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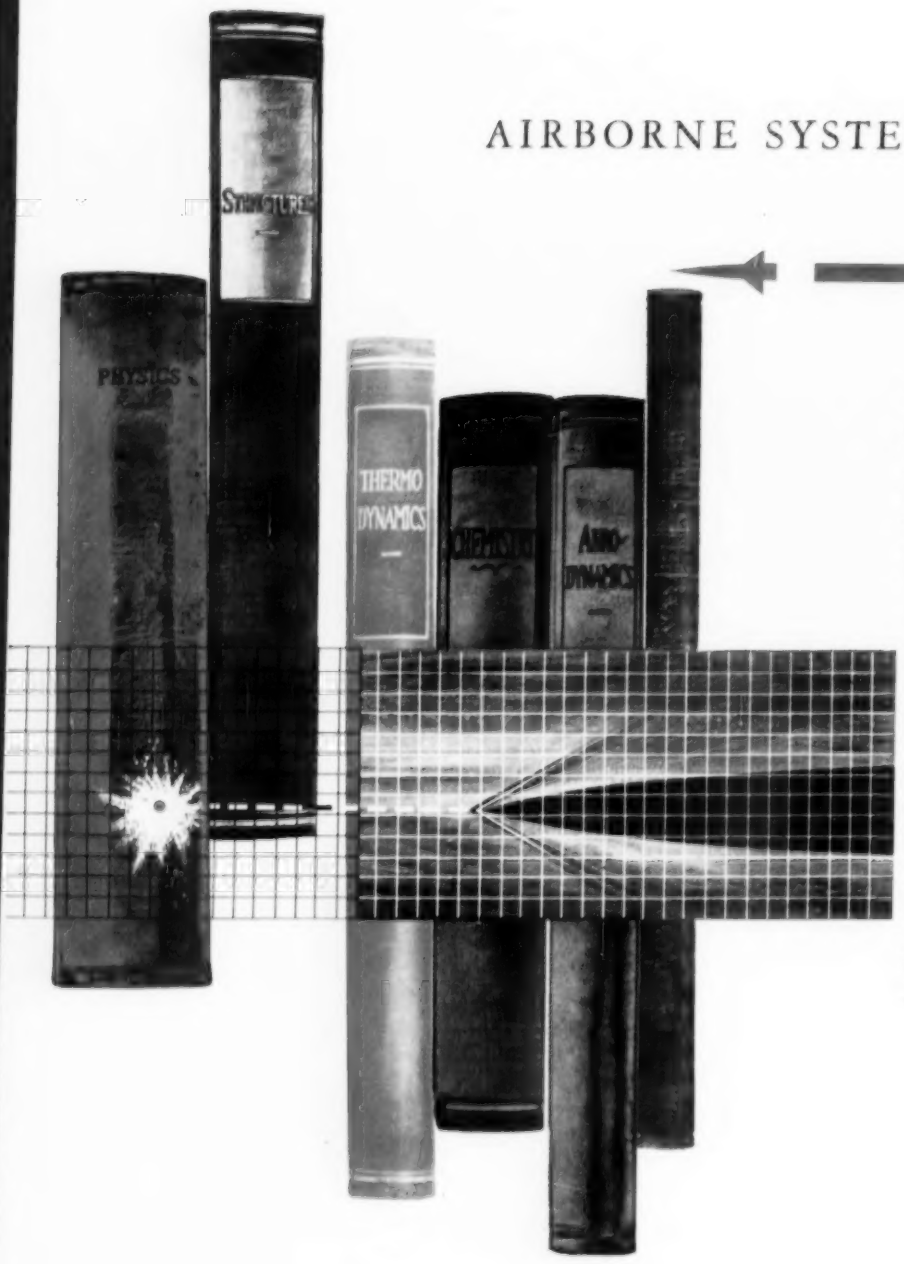

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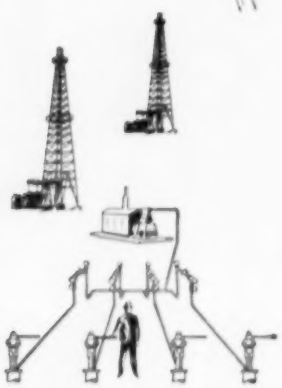

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Jan. 6-8—Fourth National Symposium, Electronics Reliability and Quality Control, Hotel Statler, Washington, D. C.

Jan. 9-10—Meeting of Airlines Proximity Warning Indicator & Air Collision Avoidance System Committee, Hollywood-Roosevelt Hotel, Los Angeles, Calif. Open to public only Jan. 9.

Jan. 13-15—10th Annual National Convention, Helicopter Association of America, Western Hills Inn, Dallas-Ft. Worth.

Jan. 13-17—1958 Annual Meeting, Society of Automotive Engineers, Sheraton-Cadillac and Hotel Statler, Detroit, Mich.

Jan. 13-May 14—Lecture series on Space Technology, sponsored by University of California and Ramo-Wooldridge Corp., to be held in Los Angeles, San Diego and San Francisco. For details write: University of California Extension, Dept. of Conferences and Special Activities.

Jan. 14-15—Yankee Instrument Fair & Symposium, sponsored by Instrument Society of America (Boston, Connecticut Valley and Fairfield County Sections), Hotel Bradford, Boston, Mass.

Jan. 18-31—14th Annual Technical Conference, Society of Plastics Engineers, Sheraton-Cadillac Hotel, Detroit, Mich.

Jan. 20—Winter Meeting, Provisional Western States Section, The Combustion Institute, California Institute of Technology, Pasadena, Calif. For details write: Mr. G. S. Bahn, Marquardt Aircraft Co., Van Nuys, Calif.

Jan. 20—"Information Theory and the Communications Engineer," speaker: Dr. Marcel Golay, consultant, physical Sciences Auditorium, University of Pennsylvania, Philadelphia.

Jan. 20-21—First Annual General Meeting, Association of Local and Territorial Airlines, Washington Hotel, Washington, D. C.

Jan. 20-Feb. 7—Aviation Institute for Commercial Carriers and Business Pilots, Univ. of Southern California, Los Angeles.

Jan. 22-26—First International Air Show &

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(*Continued from page 5*)

Exposition, Master Field, Miami, Fla. For details write: P.O. Box 2879, Miami 17.

Jan. 27-30—26th Annual Meeting, Institute of the Aeronautical Sciences, Sheraton-Astor Hotel, N.Y.C. Honors Night Dinner, Jan. 29.

Jan. 29-31—Fourth Annual Meeting, American Astronautical Society, Main Auditorium, Engineering Societies Bldg., 29 W. 39 St., N.Y.C.

Jan. 30-31—American Society for Engineering Education, 1958 College-Industry Conference, U. of Michigan, Ann Arbor.

Jan. 30-31—Seventh Annual Instrument Short Course, sponsored by Southern California Meter Association and Los Angeles Harbor Junior College, at Los Angeles Harbor College, Wilmington, Calif.

Feb. 3-4—Industry-Service Symposium Flight Control-Panel Integration, Biltmore Hotel, Dayton, Ohio. For details: Mr. J. H. Kearns, Box 942, Dayton.

Feb. 19—"Are Flying Saucers Fact or Fancy?, Dr. Hugh Winn, Missile and Ordnance Systems Department, GE., Engineers Club, Philadelphia, Pa.

Mar. 13-14—Second National Conference on Aviation Education, Hotel Mayflower, Washington, D. C.

Mar. 17-20—Joint Aviation Conference, American Rocket Society-American Society of Mechanical Engineers, Statler-Hilton Hotel, Dallas, Tex.

Mar. 17-21—1958 Nuclear Congress, managed by American Institute of Chemical Engineers, 25 W. 45 St., N.Y.C.

Mar. 18-19—Conference on extremely high temperatures (over 30,000K), sponsored by USAF Cambridge Research Center, L. G. Hanscom Field, Bedford, Mass.

Mar. 18-19—First Interscience and Industry Symposium on Guided Missiles Training Equipment (limited to those with Secret clearance) Naval Ordnance Laboratory, White Oak, Silver Spring, Md. For details write: Mr. J. G. Vaeth, Head of New Weapons & Systems Division, U. S. Naval Training Device Center, Port Washington, L. I., N. Y.

Mar. 24-29—Fourth International Instrument Show, Caxton Hall, London.

Mar. 30-Apr. 1—RFC-RNAS Reunion (World War I), Toronto, Canada. Contact: C. B. Stenning, Chairman, 149 South Drive, Toronto 5.

Apr. 8-10—Eighth International Symposia, Electronic Waveguides, Microwave Research Institute of Polytechnic Institute of Brooklyn Engineering Societies Bldg., 29 W. 39 St., N.Y.C.

Apr. 14-18—Annual Technical Meeting, American Welding Society, Hotel Statler, St. Louis, Mo.

Apr. 16-19—14th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

Apr. 17-18—Institute of Environmental Engineers, Second Annual Technical Meeting, New Yorker Hotel, New York.

Apr. 22-24—1958 Electronic Components Conference, Ambassador Hotel, Los Angeles, Calif.

Sept. 1-7—1958 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

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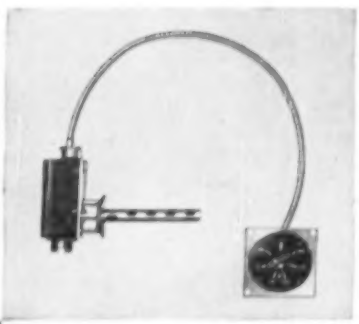

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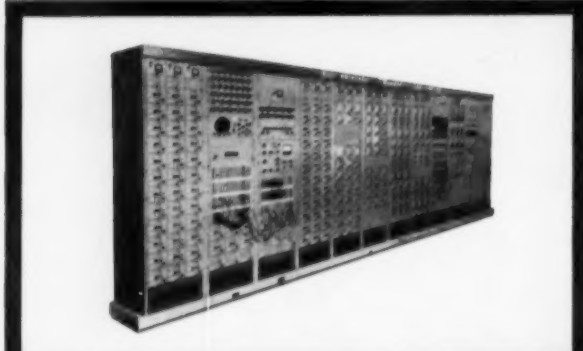

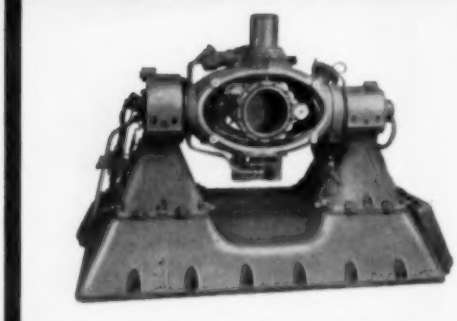

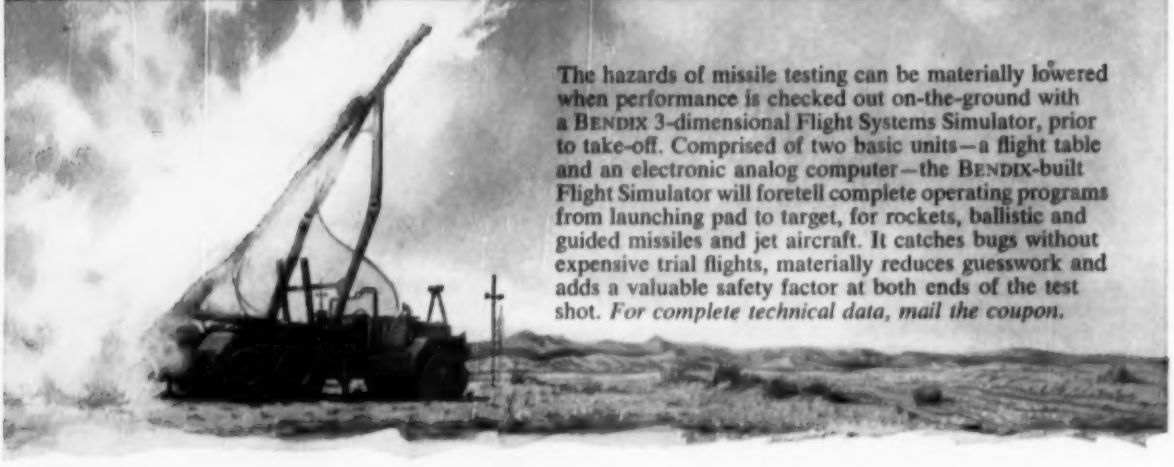

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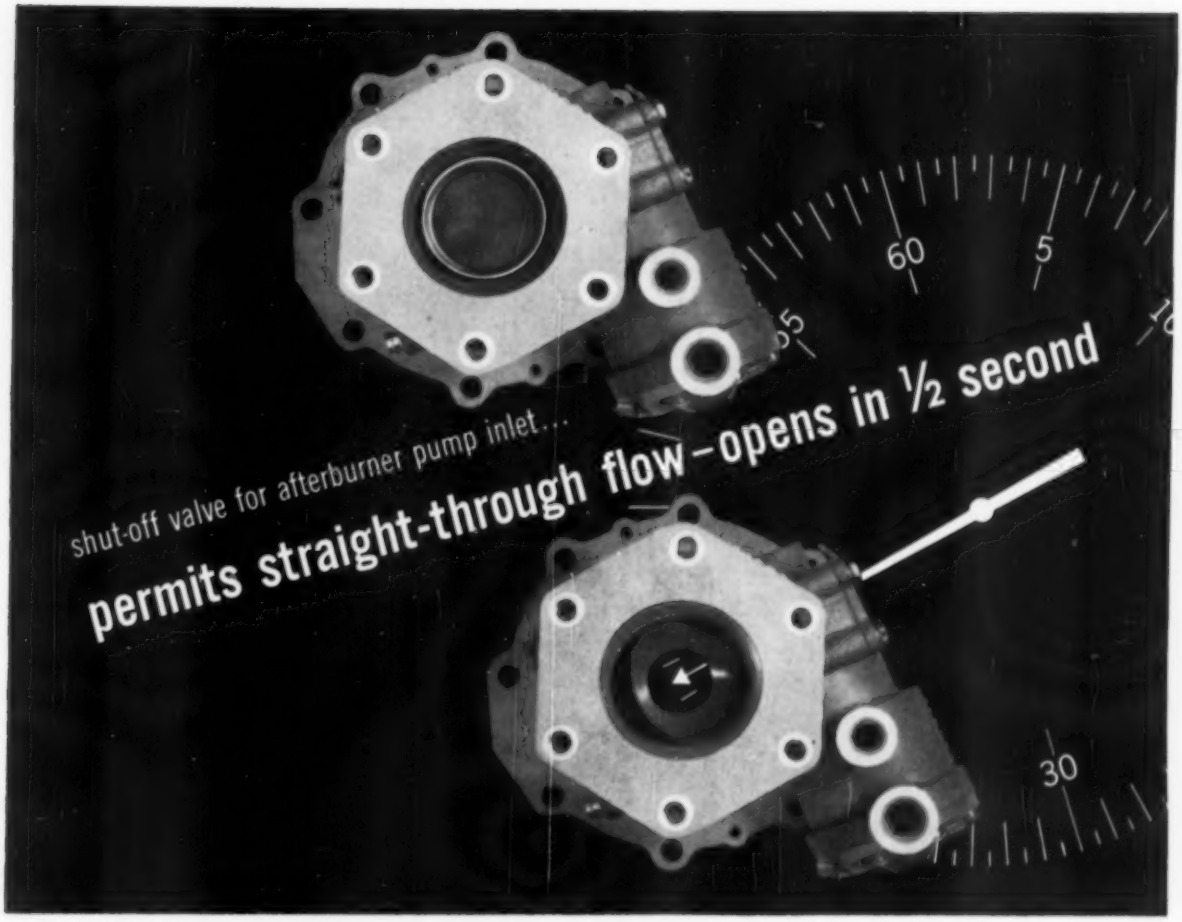

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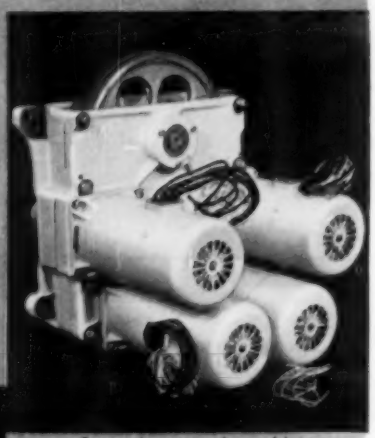

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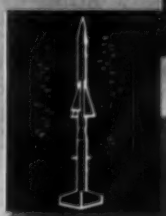

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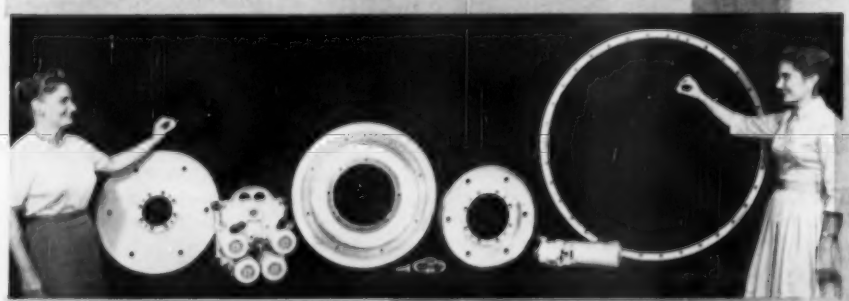

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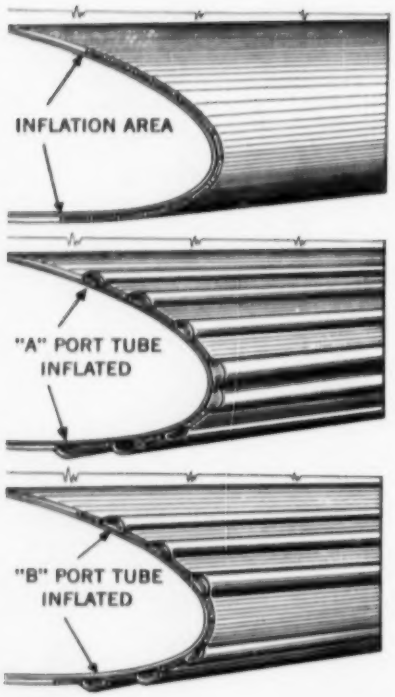

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EDITORIAL

Laurels for 1957

Once again it is the fading time of year when it is appropriate to take a final backward glance at the previous 12 tumultuous months before facing the tasks of tomorrow.

The year 1957 has been a roller coaster of financial, emotional and technical peaks and valleys for aviation. It was a year in which the smug dream of indefinite U.S. superiority in technical weapons development was finally shattered by the Soviet ICBM and the Sputniks. It was a year in which the patterns of the past began to crumble and the outline of the future began to form. Aviation's next year will be filled with the struggle over the issues, domestic and international as well as military and commercial, spawned in 1957.

This year is one in which the list of culprits who should be assessed for blame would undoubtedly be more appropriate and run much longer than our annual apportionment of laurels for achievement. But it is achievement we wish to emphasize, and here are the people and organizations who made major contributions in 1957:

• **McDonnell Aircraft Corp.,** Pratt & Whitney Aircraft and USAF Major Adrian Drew for combining to bring the world speed record back to the U.S. with the F-101A and its 1,207 mph. performance at Edwards AFB.

• **Douglas Aircraft Corp.'s** missile division at Culver City, Calif., for bringing the Thor intermediate range ballistic missile literally from paper to production as a complete weapon system in 1957.

• **Neil McElroy** for taking over the Department of Defense when it was committed to a policy of expenditure slicing, production stretchouts, indifference to basic research and complacency about the Soviet challenge and courageously reversing most of these trends, proving himself a man of vision, courage and decision.

• **Dr. James Harold Doolittle** for his ceaseless, untiring and often unsung efforts to fight for his country's needs in research and development of new weapons and for creation of the airpower in being required for adequate national defense.

• **Bell Helicopter Corp.,** Vertol Aircraft Corp. and the Sikorsky Division of United Aircraft Corp. for bringing to the flight test stage gas turbine powered helicopters and opening the era of that machine's greatest utility.

• **Ryan Aeronautical Co.** for proving in flight with its X-13 Vertiplane the feasibility of jet powered vertical rising and landing aircraft and opening another door on the future.

• **Vice President Richard Nixon and Sen. Styles Bridges,** distinguished Republicans, for the courage to face squarely the issues posed by the Soviet challenge in science and new weapons and turning the cry for necessary action in this country into a bi-partisan effort.

• **United Air Lines** for its improvement in passenger service and drive toward the top of the domestic airline heap.

• **Congressman John Moss** for his tenacious and intelligent fight against the perpetrators of secrecy in government and policies that deny the American public the right to know how its government is executing its mandates.

• **Lockheed Aircraft Corp.** for getting its Electra turboprop transport prototype into the air several weeks ahead of schedule and flying its Jetstar executive transport.

• **Carter Burgess** for his determined drive to get Trans World Air Lines back into a profitable and competitive spot both domestically and internationally.

• **Sen. Lyndon Johnson** and his committee counsel, Edward Weisl, for their vigorous, scrupulously fair and exceedingly informative conduct of the Senate investigation into the U.S. position in military airpower and new weapons development.

• **Boeing Airplane Co.** for rolling out and flying its first production line version of the 707 jet transport.

• **Maj. Gen. Arno H. Luehmann** for injecting new vigor and direction into a badly sagging Air Force public information program.

• **Convair Division of General Dynamics Corp.** for the flight test program that made its Fort Worth Division's B-58 Hustler the first bomber in the world to surpass Mach 2.

• **AC Spark Plug Division** of General Motors Corp. for its development of the Thor IRBM inertial guidance system successfully demonstrated by flight test at Cape Canaveral, Fla.

• **Eastern and Western Airlines** for opening nonstop service to Mexico by U.S. flag carriers.

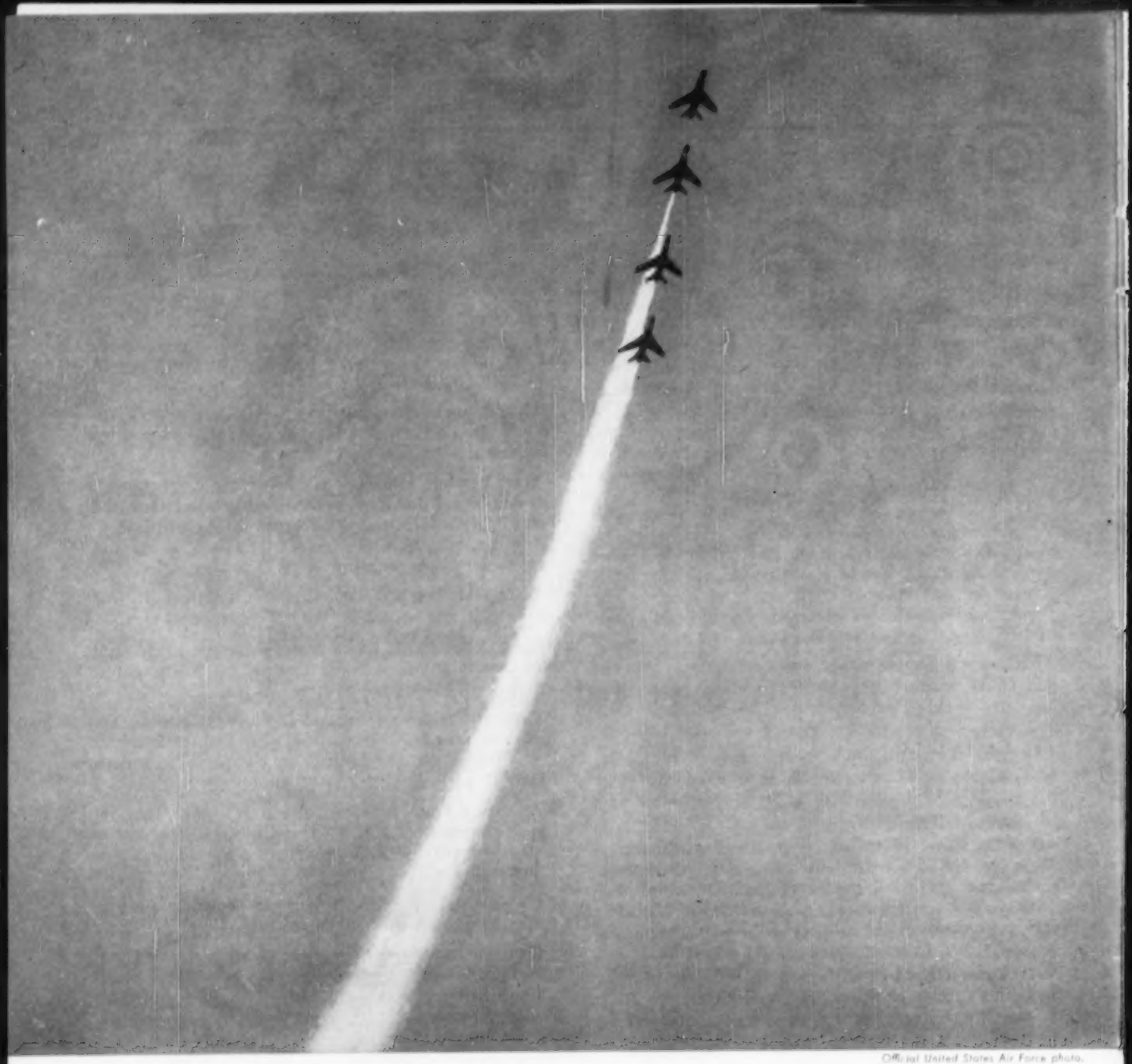
• **Gen. Thomas Power,** new chief of Strategic Air Command, for moving vigorously to augment SAC's manned aircraft striking force with missiles such as the Bell Rascal, Northrop Snark and preparing to train ballistic missile groups.

• **Edward P. Curtis** for his excellent blueprint for solving the knotty civil aviation problems posed by the jet age and the final report of his group while he served as special aviation facilities planning adviser to President Eisenhower.

• **Civil Aeronautics Board** for slicing through the Gordian knot that has previously defeated all attempts to really solve the increasingly acute airspace problem. CAB's assumption of its legal responsibility for airspace allocation was the first step toward a genuine solution of this problem.

• **USAF's Air Research and Development Command** for its scientific foresight in pushing research aimed at laying a foundation for a U.S. space program and for its courage in sticking to this goal despite active discouragement by the Department of Defense.

—Robert Hotz



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WHO'S WHERE

In the Front Office

Gwilym A. Price, board chairman, Westinghouse Electric Corp., Pittsburgh, Pa. **Mark W. Cresap, Jr.** succeeds Mr. Price as president. Also **E. V. Huggins,** executive committee chairman and vice president, and **John K. Hodnette,** executive vice president.

E. A. Bellande, vice chairman of the board, the Garrett Corp., Los Angeles.

R. T. Silberm, president, Kin Tel Division, Cohu Electronics, Inc., San Diego, Calif.

John N. Rodgers, director, Air Transport Division, Defense Air Transportation Administration, U. S. Department of Commerce, Washington, D. C.

Andrew W. Duncan, director, small business policy, Office of the Assistant Secretary of Defense, supply and logistics, Department of Defense, Washington, D. C.

Honors and Elections

The Institute of the Aeronautical Sciences has elected the following vice presidents for 1958: **Neil Burgess,** Manager, J79 project, General Electric Co.; **Gen. B. W. Chidlaw,** vice president and director, Thompson Products, Inc.; **L. Eugene Root,** vice president and general manager, Lockheed Missile Systems Division; **H. Guyford Stever,** aeronautical engineering professor and associate dean, M.I.T. School of Engineering. **R. Dixon Speas,** aviation consultant, R. Dixon Speas Associates, has been elected treasurer.

John H. Clemson, vice president of Trans World Airlines, has been appointed an adviser to the Defense Air Transportation Administration, U. S. Department of Commerce, on temporary assignment beginning Jan. 1.

Patrick E. Haggerty, executive vice president of Texas Instruments, has been elected a fellow of the Institute of Radio Engineers "for leadership in the advancement of the semiconductor industry."

Changes

Dr. George F. Mechlin, Jr., director of advanced systems engineering for Polaris, Sunnyvale Division, Westinghouse Electric Corp., Pittsburgh, Pa.

Col. Leonard F. Harman (USAF, ret.) has joined the staff of the aircraft nuclear propulsion department, General Electric Co., Cincinnati, Ohio.

Capt. Charles E. Trescott (USN, ret.), manufacturing manager, Zenith Plastics Co., Gardena, Calif.

Fred S. Miller, manager-solid propellant production, and **J. B. Cowen,** manager-manufacturing, solid rocket plant, Aerojet-General Corp., Sacramento, Calif.

Bertram Mintz, technical representative-research and development (Dayton, Ohio), Marquardt Aircraft Co., Van Nuys, Calif.

Gerald R. Sauer, manager, Sage powerhouse operation, Radio Corporation of America, Topsham, Mass.

Werner K. Gengelbach, assistant manager of Air Force missiles projects, Aerophysics Development Corp., Santa Barbara, Calif.

INDUSTRY OBSERVER

► Thor intermediate range ballistic missile production scheme at Douglas Aircraft Co.'s Santa Monica Division accommodates parallel assembly lines in relatively small width of factory area, indicating the possibility of fast expansion for stepped-up production.

► **Pratt & Whitney Aircraft is proposing a new, more powerful version of its 5,700 eshp. T34 turboprop powerplant to the Air Force. Designated the PT2G-6, the new engine would also have better high altitude characteristics and other improvements. Engine is intended primarily for latest models of Douglas' C-133 cargo transport.**

► Army's Jupiter IRBM reportedly will require a new fuel anti-sloshing baffle design as well as major changes in airframe design before it can be placed into actual production.

► **Wright Air Development Center personnel have recently completed a three-week tour of the U. S. to investigate the status of projects related to astronautics. Aim is to reorient WADC thinking so that it can blend its activities into the progress being made by industry in this field.**

► Douglas Aircraft Co. may invest as much as $10 million to begin and accelerate various projects in the field of space travel and related projects.

► **North American Aviation's Rocketdyne Division has not yet received additional orders for its 165,000 lb. thrust liquid propellant engines although Air Force Thor and Army Jupiter intermediate range ballistic missiles, both of which use this powerplant, have been ordered into production.**

► Air Force has received approximately 250 proposals for moon shots and space travel from various industry companies and individuals within the last few months, a number of them since Russia's Sputnik I.

► **Joint proposal to Airways Modernization Board by Sperry Rand, Radio Corp. of America and Airborne Instruments Laboratory for design of semi-automatic traffic control data processing system, is reportedly one of the top contenders in the AMB competition. An announcement by the board on its choice of contractor is expected shortly.**

► Progress on Polaris fleet ballistic missile which has generated so much Navy enthusiasm includes development of a guidance system containing extremely fast gyroscopes and small enough to be carried in Polaris. Inertial system grew out of work by Dr. C. S. Draper at Massachusetts Institute of Technology which has been sponsored by Navy and Air Force.

► **Navy's success with the U. S. Compass Island (EAG-153) navigation research ship, commissioned only a year ago (AW Dec. 10, 1956, p. 28), has put it two years ahead of its goal in navigation accuracy. Ship is capable of automatic photoelectric star tracking in daylight, gyroscope measurement of latitude and accurate measurement of speed over ground; uses Ship Inertial Navigation System. Work is an important part of Polaris fleet ballistic missile program.**

► Air Force is sharply trimming its original plans for procurement of the Lockheed F-104. Cutback in original program for 137 wings is being felt most by Tactical Air Command which had planned to equip a number of superiority fighter wings with the F-104. Now, USAF planners say, TAC will have "not very many" superiority fighter wings.

► **Production of advanced version of shipborne Convair Terrier anti-aircraft missile has been held down considerably by budget limitations below what Navy's Bureau of Ordnance had wanted. Progress on Navy's Tartar anti-aircraft missile also has suffered several months' delay because of limitation on Fiscal 1958 funds.**

► Soviets have incorporated mine laying equipment on almost every ship and submarine built since World War II. U. S. Navy considers the mine threat one of its top priority problems, close behind detection and destruction of Russia's 500-odd submarines. Navy, which has only 110 submarines, considers itself ahead of Russian sub fleet in techniques but needs more of every type of anti-submarine equipment and more mine countermeasures ships.

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Washington Roundup

Bureaucracy Pyramid

Pentagon bureaucracy at work: Office of Perkins McGuire, Assistant Secretary of Defense for Supply and Logistics, now has a staff of more than 250 people. Their job is to overlook the armed forces in the areas of procurement, production, supply and transportation. By contrast, the office of Dudley C. Sharp, Assistant Secretary of the Air Force for Materiel, has 26 persons enrolled, including the USAF panel of the Armed Forces Board of Contract Appeals. Sharp is in charge of USAF spending—the biggest procurement budget in America.

Soviet De-Emphasis

Latest Russian de-emphasis of armed might (see page 19) came from Soviet Communist Party Chief Nikita Khrushchev, who hinted that NATO countries' declaration against the use of force plus the "development of science and engineering in our country" might lead to reduction in Russia's military services.

Moscow Radio quoted a Khrushchev speech to the Ukrainian Republic's Supreme Soviet in which he said Russia's Supreme Soviet had asked the government to study "a further reduction . . . maintaining (the services) at a level fully insuring the interests of the country's defense." In addition to NATO declarations, the broadcast said, scientific and engineering progress was being considered because it "enables us to do this with a smaller expenditure of means so that the means and manpower thus released could be channeled to peaceful construction."

CAB Ethics

A report by the Senate Government Operations Subcommittee dealing with an alleged "leak" from Civil Aeronautics Board of the award of a New York-Miami route to Northeast Airlines is now being circulated among subcommittee members for approval.

At hearings last May, Raymond Sawyer, then associate director of CAB's International Division, protested testimony by Laurence Henderson, sales representative of Fairchild Airplane and Engine Co., indicating that Sawyer was the source of the leak (AW May 13, p. 43). Sawyer is now assigned to the International Cooperation Administration in Addis Ababa, Ethiopia.

Sen. Henry Jackson (D.-Wash.), chairman of the Government Operations Subcommittee which conducted the hearings, plans to push legislation establishing criminal penalties for both CAB employes who leak confidential information and for individuals who attempt to "pressure" Board members. The measure, which Jackson introduced late in the last session, is pending before the Judiciary Committee.

Embarrassing Skeleton?

Airlines have obviously taken to heart a suggestion by Civil Aeronautics Board member Louis J. Hector that more details on financing requirements for jet transports is essential before the CAB can establish the need for a fare increase. General Passenger Fare Investigation, now in recess for the holidays, has been distinguished by a parade of top Wall Street bankers and brokers testifying on the unattractive financial character of the airlines from an investor's point of view.

One banker expressed his views on airline stocks during the hearings by saying he wouldn't touch them "with a 10 foot pole." While such testimony may contribute to a favorable board decision on a fare increase as Hector tacitly said it might, it hasn't made any new friends among investors. When the time comes for large equity financing to cover the purchase of jet equipment, airlines may find their dismal testimony backed by full Wall Street agreement an embarrassing skeleton in the cupboard.

Turn to Congress

Meanwhile, some domestic airlines are proposing that the industry turn to Congress for a fare increase and a way out of its present financial difficulty, pointing out that a decision in the General Passenger Fare Investigation is almost a year away.

Other airlines oppose any such move on the grounds that Congress would shy away from such legislation. More important, they feel that rate regulation should remain with the Civil Aeronautics Board.

Airlift Hearings

House Government Operations Subcommittee on the Military headed by Rep. Chet Holifield (D.-Calif.) plans hearings on Defense Department's airlift program promptly after the reconvening of Congress, probably beginning Jan. 8. Among other aspects, the subcommittee will go into USAF's new proposal to have commercial airlines operate five aircraft of Military Air Transport Service in the Atlantic area and five in the Pacific area as direct arms of MATS. The airlines want to lease the aircraft from MATS and use them for commercial as well as military traffic.

Several other committees also are interested in the airlift situation. Senate Appropriations Committee has asked Defense Department to submit a report by Jan. 15 on the portion of military traffic being handled by commercial airlines. The committee proposed that MATS should channel 40% of its passenger and 20% of its cargo traffic to commercial lines. A special subcommittee of Senate Commerce Committee headed by Sen. Mike Monroney (D.-Okla.) also is making an investigation.

French Bilateral

Breaking off of U.S.-French bilateral talks in Washington shortly before Christmas does not necessarily mean the State Department has stiffened its stand against French demands. There are strong indications that State is willing to give the French air rights to Los Angeles but would like to receive something in return.

The French, on the other hand, are in no mood for trading, even to the point of making minor concessions.

The French demanded a route to the U. S. West Coast at the time Pan American World Airways and Trans World Airlines were getting set to begin Polar service from the U.S. to Paris. The French said the present U.S.-French bilateral agreement did not authorize a Polar route, but they would permit U.S. carriers to land, providing Air France also received a Polar route. Talks will resume late in January or early February after negotiators have had an opportunity to discuss the matter with their respective governments. —**Washington staff**

McElroy May Take Second Jupiter Look

Defense decision to produce Thor and Jupiter may be altered, result in abandonment of Army IRBM.

By Claude Witze

Washington—There is a strong possibility that Defense Secretary Neil H. McElroy will take a "second look" at his decision to produce both the Army Jupiter and USAF-Douglas Thor intermediate range ballistic missiles.

Informed observers see these factors favoring reconsideration of the program:

- **NATO "summit" meeting at Paris** reached a decision to accept U. S.-built intermediate range ballistic missiles in principle only, leaving the final decision to the individual countries.
- **Cost of developing** duplicate production line and ground equipment for Jupiter is substantial. Two-thirds of the cost of an IRBM weapon system is invested in ground equipment.
- **Inspection of missiles,** equipment and facilities at the Army Ballistic Missile Agency, Huntsville, Ala.; the Chrysler Corp. plant in Warren, Mich., and at the Douglas plant in California has demonstrated that the Air Force project is at least a year ahead of Jupiter. Prototype of the Thor passed its Development Engineering Inspection with ease, manned at the site by Strategic Air Command crew.
- **Increasing pressure for replacement** of William M. Holaday, director of guided missiles, who is held mainly responsible for the decision to produce both missiles. Holaday's appearance before the Senate Preparedness Subcommittee (AW Dec. 23, p. 20) has created fairly wide dissatisfaction with his handling of a key Pentagon post.
- **Successful Thor firing** from Cape Canaveral, Fla., on Dec. 19. This demonstration is described in authoritative circles as the first fully complete and successful firing of a ballistic missile in U. S. history. It was a test of all components, completely integrated. It flew its prescribed course and landed in the preselected impact area.

Supplemental Funds

On his return from the Paris NATO meeting, Defense Secretary McElroy announced he is about to ask Congress for $1 billion "for missiles and other things" as a supplementary appropriation in the current fiscal year. It was estimated earlier that at least $100 million would be needed to get the Thor-Jupiter program moving to meet the promised date of deliveries to Great Britain and other European allies before the end of calendar 1958.

Actually, the "shotgun wedding" of the two missiles took place despite near-violent protests from the Air Force. It was viewed at the time as a move made less for pure military considerations than political ones. The announcement on the eve of the Paris conference made it possible for the U. S. to seek agreement on the use of IRBMs at the meeting.

Now it is assumed that the "heat is off" because of the inevitable delays that will follow in reaching missile agreements with individual nations. In addition, many U. S. allies have misgivings about the wisdom of letting their territory be used for U. S. missile bases, and there are no signs that the resistance will be alleviated.

IRBM Tour

On top of this, more facts are coming to light about the tour of IRBM facilities undertaken three weeks ago by USAF Secretary James H. Douglas (AW Dec. 16, p. 27). Douglas was accompanied by Holaday, Army Secretary Wilber M. Brucker and his two top USAF production experts, Lt. Gen. Clarence S. Irvine and Brig. Gen. W. Austin Davis.

In contrast to the workable Thor model demonstrated at the Douglas plant, the Huntsville Arsenal did not have on hand any ground equipment for Jupiter.

The production prototype had not been completed.

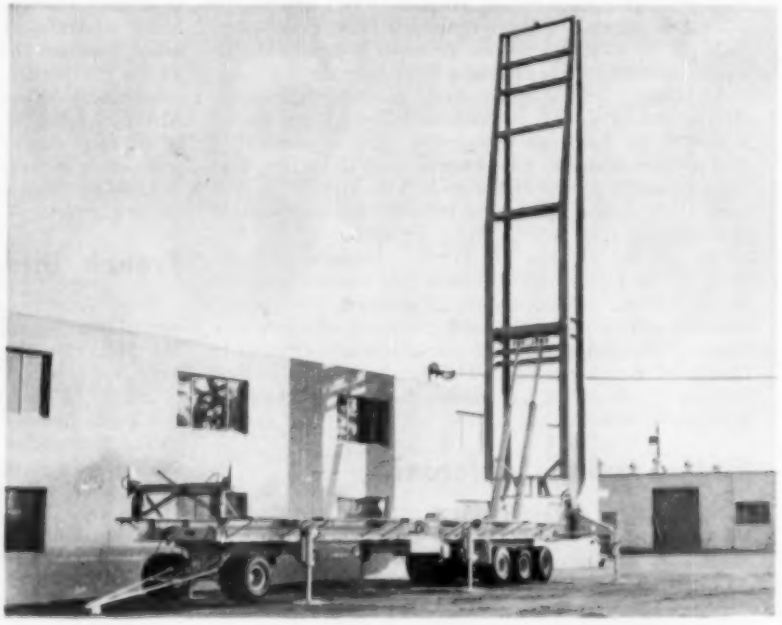
Douglas was able to demonstrate that Thor is air transportable. The missile and necessary ground equipment can be loaded in C-124 or C-133 aircraft. The Army has not designed any equipment to make Jupiter mobile by aircraft, concentrating on future ability to move the weapon on the ground.

Ready Crews

In contrast with the uniformed Strategic Air Command crew prepared to man the Thor, Douglas and his inspection party found no USAF personnel ready to use the Jupiter. At the outset, the Army proposed that its own soldiers, experienced with the Redstone missile, should take charge of the Jupiter for as much as four years, later turning it over to Air Force personnel. The Air Force has rejected this suggestion, insisting that its own SAC crews must handle the weapon from the beginning.

Another strong feature of the Thor, also demonstrated to the Pentagon visitors, is the fast reaction capability of the weapon on the launching pad.

Almost entirely because of improved



Transporter Spots Polaris on Launch Pad

Trans-Erector is designed to transport Navy Polaris ballistic missile and position 47-ft. missile on launching pad. Trailer, delivered to Lockheed Missile Systems Division by Locomotion Engineering Inc., is about 60 ft. long, 9 ft. wide, 8½ ft. high, weighs about 54,000 lb.

WS-110A Order

Washington—USAF last week awarded North American Aviation Inc. a contract for development of the WS-110A Mach 3 chemical bomber designed as a replacement for the Boeing B-52 intercontinental jet now being delivered to the Strategic Air Command.

Both North American and Boeing Airplane Co. were competing for the contract. Designated the WS-110A, the aircraft will be powered by a new engine under development by the General Electric Co.

No dollar value was announced for the North American contract. The current Air Force budget for Fiscal 1958 included an allocation of about $90 million for work on the aircraft and the engine.

ground handling equipment, a Thor squadron could fire its first missile, once the order is given, about two and a half times faster than a Jupiter squadron.

For a full squadron of 15 missiles, it is estimated that the Thor unit would be on target ten times faster than its Jupiter counterpart if they both receive the firing order at the same instant.

Thor, on the launching pad, will be ready 24 hours a day with not more than 15 min. needed for countdown.

Germans Evaluating U. S. Planes in Flight

Los Angeles—West German team evaluating interceptors and fighter-bombers for major re-equipment of the new Luftwaffe (AW Dec. 16, p. 27) is expected to complete in-flight evaluation of all available aircraft before the end of 1957.

Final flight test was made on the Lockheed F-104A about Dec. 16. Team, headed by Lt. Col. Albert Werner, Chief, Tactical Technical Requirements, German Defense Ministry, flew the Grumman F11F-1F in a comparative evaluation.

Flight tests produced a crop of rumors in Europe that the Germans had made a final choice, but most informed observers believe the situation reported in AVIATION WEEK still stands and that there will be no choice before spring.

Team, which arrived in U.S. last week, approximately one month ahead of schedule, was to visit Air Force Flight Test Center at Edwards AFB, Calif. Aircraft specifically mentioned were the F-104A and F11F-1F, but Germany also is interested in Convair F-102A and F-106A, North American F-100D and F-100F, Northrop N-156F and Republic F-105A.

U. S. Reaction to Sputnik Threat May Have Spurred Soviet Caution

Moscow—Lag between launchings of Sputnik II and Sputnik III may indicate Russian concern over the degree to which earlier launchings have alerted U.S. to the Soviet technological-propaganda threat. Sputnik I was launched on Oct. 4 and the II on Nov. 7.

There are other indications that Russia underestimated U.S. response and now is attempting to de-emphasize her relative scientific and military strength (see page 17).

Urges Effort

Alexander Nesmeyanov, president of the Soviet Academy of Sciences, told the Supreme Soviet (parliament) last week that great effort will be needed to put Russian science ahead of science in the U.S.

"It would be most harmful," he warned, "to overestimate our scientific achievements." Nesmeyanov said Russia should emulate the U.S. in science and told the Supreme Soviet the U.S. puts money into scientific research at a much greater rate than Russia.

Possibly with greatly renewed U.S. emphasis on science in mind, Nesmeyanov critized antiquated equipment, useless expenditures and duplication in Russian scientific work and pointed out that the $4.55 billion earmarked in the new budget for "development projects" is only 10% more than Russia spent in 1952. He said the annual increase in the U.S. is 12% a year.

Nesmeyanov also complained that the expenditure for equipment in 1957 totaled 5,300 rubles per scientist (at four to the U.S. dollar) versus 9,000 in 1954. He also said U.S. industrial firms turn 10 to 15% of their profits back into research work and observed that they would not do so "if it wasn't profitable."

'240,000 Scientists'

The academy chief also found good things to say about Soviet science. He said Russia has "an army of 240,000 scientists" now and is graduating 250,000 technicians and specialists a year.

"The effect of the Sputniks and other scientific achievements of the U.S.S.R. is very great and the United States is having to admit it is behind the U.S.S.R. in certain respects," Nesmeyanov said.

Sputniks demonstrate not only Russia's superiority in rocket techniques but also to "the great progress in the realms of mechanics, mathematics, chemistry, radio technique and automation," he said.

Nesmeyanov told the Supreme Soviet that "investment in science will be returned a hundred times," and said: "We have everything we need to raise Soviet science to first place in the world."

Russia's new budget, presented at the same time, calls for approximately the same defense expenditures but continues emphasis on heavy industry.

Emphasis on Chemistry

It also calls for a 53.6% increase in capital investment in the chemical industry and reveals that Russia will build 50% more airports next year than this year.

This is the first one-year plan presented since industrial management was decentralized. More than 30 industrial ministries have been abolished, and planning and management of industry has been divided among 90 economic districts.

Aviation and defense ministries also have been reorganized (AW Dec. 23, p. 17).

New Soviet Bomber

Moscow—Red Star, Soviet Army publication, reported last week that the Russians have successfully test flown a new long-range jet bomber.

Terming the aircraft "colossal," the Red Star article said it has flown higher and longer than any other aircraft of its type. The bomber may be a follow-on to the Bison intercontinental bomber reported in Aviation Week last July 8 (page 23), which has two engines on each side, with the two powerplants mounted in the wing roots one above the other.

Britain's Second SR.53 Makes First Flight

London—Saunders-Roe's second SR. 53 mixed powerplant interceptor has made its first flight from Boscombe Down.

The second aircraft, built under a Ministry of Supply contract, has what the company describes as "considerably greater" rocket propellant capacity than the first aircraft. The SR. 53 is powered by a de Havilland Spectre rocket engine and an Armstrong Siddeley Viper jet engine.

The first SR. 53 made its maiden flight on May 16.

Both aircraft are being used in a flight test program to obtain data for the advanced SR. 177.

AIA Estimates Industry Sales Were $11.5 Billion in 1957

Washington—Aircraft Industries Assn. estimates that 1957 sales for the aviation industry were $11.5 billion, up from $9.5 billion in 1956 despite a slash of 100,000 in employment and widespread contract cancellations.

For the coming year, AIA president Orval R. Cook anticipates the industry will roll up sales of more than $10 billion. By the end of the year, he says, deliveries of guided missiles will account for more than 35% of the total military business.

AIA expects employment will continue to decline, going well below 800,000 and that some plants will be closed. Present total employment is approximately 845,000. At the same time, there will be new facilities provided, particularly for research and development and production of newer types weapons.

Backlog $14.4 Billion

Backlog of unfilled orders at the end of the third quarter of 1957 was $14.4 billion, compared with $18.4 billion for the same period of 1956. A year from now, AIA predicts, at least half of the military backlog will be in orders for guided missiles.

In an annual summary of the industry's situation, Cook calls 1957 "the most extraordinary in the history of the aircraft manufacturing industry."

Clearly referring to the financial crisis of last summer, which culminated in a limitation on the amount of money USAF would pay on each contract regardless of delivery schedules, Cook says AIA member companies anticipated a gradual decline.

The financial crisis, however, turned the gradual decline into a near-panic that was stopped only when Russia visually demonstrated its technological superiority with Sputniks I and II and reversed some of the administration's financial policies.

Before the Soviet launching of its satellites, the Defense Department ordered contract stretchouts, program cancellations, limits on overtime, lower progress payments. These cut employment, closed some plants and slashed expenses. Meanwhile, the industry was asked, at least by its biggest customer, the Air Force, to finance more of its own work.

Policy Reversal

The policy reversals followed public reaction to the Russian successes. By the end of the year, many of the restrictions had been removed, missile and space projects were being accelerated and there was strong likelihood that more money would be made available.

Cook made it clear that the lag was not due to aircraft industry failures. He pointed out that there are 43 announced missile projects under development or in production and that AIA member companies have major roles in the program.

The AIA survey points out that there is no relation between the 1957 record sales figures and production of military aircraft. Deliveries to the Army, Navy and USAF declined from 6,800 units in 1956 to slightly more than 5,000 in 1957. On the other hand, in addition to the missile output, commercial sales for the first time topped $2 billion, up more than $500 million from the previous year.

Inflation Ups Cost

Inflation was blamed for part of the changes. Index of aircraft materials averaged 152 as compared with 109.2 in 1950. Average hourly earnings were $2.36 as compared with $2.27 in 1956. The average work week was down from 42.1 to 40.5 hours in the year.

Other figures from the AIA report:

• **Dollar value of commercial deliveries** went up in 1957 to $725 million, from $454 million in 1956. Airlines bought 325 planes, compared with 206 in 1956.

• **Value of utility aircraft deliveries** will be about $100 million, the same as 1956. The number of units will be down to 6,200, compared with 6,778 in 1956.

• **Ratio of earnings to sales** is expected to suffer from unusual changes in military programs. For the first nine months, sales were $4.9 billion, compared with $3.8 billion for the same period of 1956. Earnings increased from $112.6 million to $120.1 million in the same period. Rate of earnings to sales dropped from 2.9% to 2.4%.

• **Unfilled orders for jet and turboprop** transports went up. There were 508 units, valued at $2.8 billion on the books last Oct. 31. Total transport backlog at that time was 695 units, compared with 878 for the same period in 1956.

• **Average employment** for the year was 880,000, up from the 1956 average of 814,000. There was a high of over 900,000 in the first six months of the year but it has been declining since.

• **Average weekly earnings** in 1957 were $97, up from the 1956 average of $95.57. Total AIA payroll cost for the year will be more than $5 billion, not including payrolls of suppliers, subcontractors and vendors.

Ratio of Earnings

Cook estimates that the ratio of earnings to sales will continue to slide in 1958. High level of sales will continue because of increased deliveries of missiles and commercial transport aircraft.

Military business will depend to a large degree on congressional reaction to the news from Russia and the public reaction to Soviet advances. Current close scrutiny of the nation's defense posture continues the state of industry uncertainty.

Avionic Sales

Washington—Electronic Industries Assn. says military procurement in 1957 accounted for half of the industry's sales.

Total defense deliveries accounted for $3.5 billion of the year's $7 billion in sales. Military sales are expected to increase in 1958.

Dr. W. R. G. Baker, EIA president, predicts that electronic instruments alone will provide control and communication for space ships and satellites.

Traditional radio and television sales in 1957 accounted for only 21% of the industry's total. Baker said this business has not declined, but military and commercial sales have been expanding more rapidly.

Science Data Center Proposed by Stanford

Stanford Research Institute has proposed to the government establishment of an information processing facility comparable to the Soviet All Union Institute of Scientific and Technical Information.

Stanford says that such a facility could in effect increase this country's force of creative scientists and engineers by 25% simply through time saved in laborious literature searching, plus the unknown but possibly greater saving realized by reducing duplication of research effort.

Failure to comprehend the seriousness of the information handling problem will increasingly entangle our technological society with unread literature and unused knowledge, the research facility says.

The program proposed by Stanford would consist of two steps:

• **Interim phase.** Because of the existing Soviet military threat, an immediate effort should be made using conventional survey techniques to define the scope of present technical information processing activity in this country. For

this phase, there is neither the time nor need for a profound systems-analysis of information processing operations. A valid statement of the size and general nature of the requirement will suffice.

From the survey data, the amount and kind of demand that exists for collection, translation, abstracting, codification, storage and dissemination must be determined. With this information, the first national technical information center can be established on a stopgap basis.

The initial operation will be awkward and inefficient, and the use of essentially manual techniques will require a great many people.

• **Final phase.** Once steps are underway to meet the immediate challenge, a general attack enlisting the skills of many branches of science must be made upon the ultimate problem.

The contributions of psychology, library science, linguistics, semantics, lexicography, electronics and information theory will provide the basic understanding of the component parts of the problem. The techniques of systems analysis and operations research may be used to correlate these various parts and to define the characteristics of the complete system.

This final system must be based upon a knowledge of the learning process and problem-solving mechanisms of humans, machine translation and codification of languages, memory and data-processing systems, remote reading and printing equipment, plus information patterns and inquiry characteristics for cataloging of assembled data.

Development of the ultimate system is beyond the capacity of any one organization anywhere, Stanford says. It will require the participation of many teams from industry, universities, research institutes and government laboratories.

The Soviet Institute, founded in 1952, now is staffed by more than 2,300 translators who are backed by more than 20,000 scientists and engineers who act as part time translators and abstractors. The function of the Institute is to accumulate the published technical literature of the world (some 10,000 journals from 80 countries), process it and make available the information it contains in the most useful form possible.

The Institute is sufficiently successful so that prominent American scientists have said that the best way to find out what American science is doing is to read the Russian literature. It is painfully apparent, Stanford says, that no comparable facility exists in the Western world.

New C-133A Contract Received by Douglas

Santa Monica, Calif.—Douglas Aircraft Co. has received an additional $40 million order for production of the C-133A turboprop cargo transport from USAF's Air Materiel Command.

The new contract for the cargo plane, which can be modified to transport Atlas and Titan intercontinental ballistic missiles, will extend production of the aircraft into 1961.

Aviation Week Reports Editorial Changes

Two major appointments on AVIATION WEEK's editorial staff were announced last week effective Jan. 1, 1958. William Gregory will become managing editor and Michael Yaffee will join the engineering staff specializing in missiles and astronautics.

W. H. GREGORY

Gregory has been an associate editor of AVIATION WEEK in New York since early 1956. He learned to fly in civilian lightplanes in 1942 and won his Navy pilot's wings at Corpus Christi, Tex., in 1943. He served as a carrier-based fighter-bomber pilot in the Pacific in three major invasion campaigns. He flew Vought F4U Corsairs and Grumman F6F Hellcats. He is still active in the Naval reserve. Gregory is a graduate of the Creighton University journalism school at Omaha, Neb., and came to AVIATION WEEK from five years as a reporter and desk man on the Kansas City Star. Previously, he had worked on other daily newspapers in Colorado and Iowa.

Yaffee comes to AVIATION WEEK from the American Rocket Society where he has been managing editor of its two technical journals, Jet Propulsion and Astronautics. Yaffee studied at the Universities of Chicago, New Mexico and Rome, Italy, and has a bachelor's degree in chemical engineering.

MICHAEL YAFFEE

After completing his education, Yaffee worked at the U. S. Army Picatinny Arsenal's high explosives department and the Turbine Division of General Electric Co. Yaffee was an associate editor of Chemical Week, a McGraw-Hill publication, for four years before joining the American Rocket Society as managing editor of Jet Propulsion. When the society began publishing its second magazine Astronautics early this year, Yaffee also served as its managing editor.

Leduc 0.22 Prototype Burns During Takeoff

Paris—Single existing prototype of the French Leduc 0.22 ramjet interceptor was virtually destroyed last week when fire broke out during takeoff at the Istres Test Center.

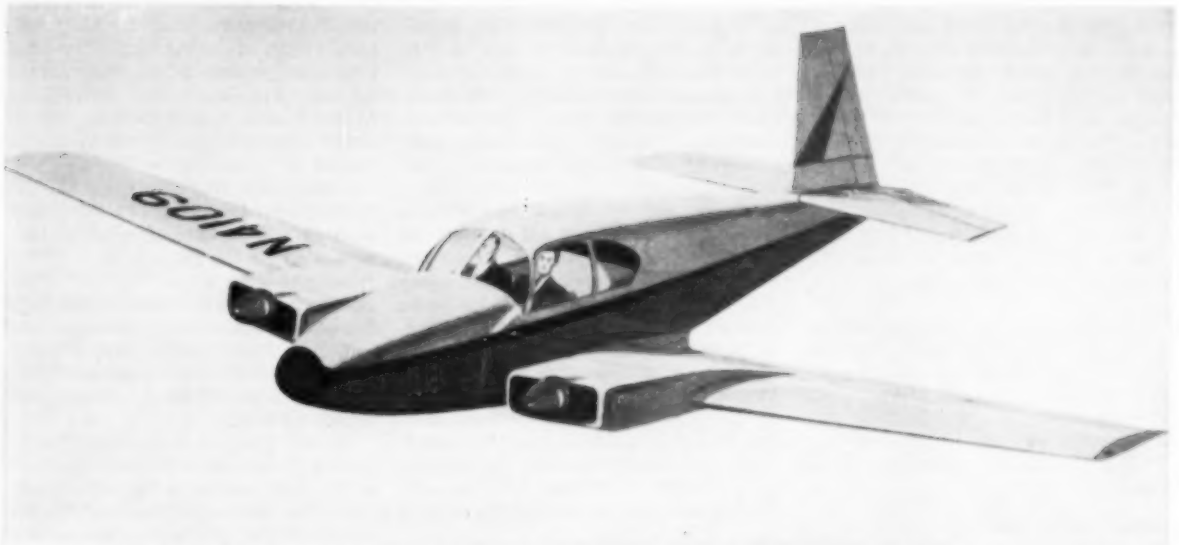
Test Pilot Jean Sarrail managed to brake the interceptor by using drag chutes but major portions of the aircraft were destroyed by fire. The pilot escaped without injuries.

Leduc interceptor primary powerplant is a ramjet though a single Snecma Atar D.3 turbojet is installed within the aircraft for use during the slow speed portion of its operation. Prototype first flew in December, 1956 and had made 140 flights over the past year despite long periods of grounding for modification.

Accident probably means all development work on the Leduc ramjet project will now come to a halt. This is because the government several months ago canceled the second Leduc prototype despite the fact it was nearly 80% completed (AW Oct. 7, p. 31). Air ministry technicians, who have financially supported Rene Leduc since his first ramjet experiments in the early 1930s, recently began to withdraw this support since much of Leduc's earlier lead over other types in development had been lost.

HR2S-1s Take Part in Carrier Operations

Marine HR2S-1 helicopters land on board U.S.S. Valley Forge in first operational maneuvers aboard a carrier in which the twin-engine Sikorsky aircraft have taken part. HR2S crews practiced takoffs and landings on cruise from New River, S. C., to Guantanamo Bay, Cuba. HMR(M) 461, the first Marine squadron to receive the HR2S, took them aboard the carrier.



MOONEY MARK 22 light twin, scheduled to come on the market in 1960, will sell for less than $30,000. Projected price now is $27,500. Airframe of prototype is basically that of single engine Mark 20 with streamlined nose and large dorsal fin, not shown in drawing above. Prototype has two Lycoming 150 hp. engines but production model probably will have 180 hp. powerplants. Current plans call for 35 gal. tip tanks and 15 gal. tanks in the rear of each nacelle, but center of gravity requirements may change this layout.

Light Twin Heads Mooney Growth Plans

By Craig Lewis

Kerrville, Texas—Mooney Aircraft Co. is expanding its line of aircraft and adopting new sales techniques in a drive to increase its share of the increasingly competitive market for light business aircraft.

Mooney completed its first $1 million sales year in the fiscal period ending October 31, and the company turned a $94,000 profit on that record volume. Sales are expected to nearly double in 1958. These are the aircraft Mooney will market in an effort to increase its share of the executive aircraft market.

- **Mark 20A**—More powerful companion to the standard Mark 20. It is equipped with a 180-hp Lycoming engine and will be available early this year.
- **Mark 22**, a light twin version of the Mark 20, is now in the prototype stage and is scheduled to be ready for the market two years from now.

Light Twin Details

Norman Hoffman, Mooney's executive vice president and director of sales, predicts that sales volume will increase 75% in 1958. To back up this prediction, Hoffman is organizing a greatly expanded sales program. And to keep its salesmen in aircraft, Mooney plans to triple production rates by next summer.

When it comes on the market early in 1960, the Mark 22 will be the biggest aircraft in the Mooney stable, although the change over the Mark 20 is more in performance than in size. Mooney expects to sell its new light twin for less than $30,000, and right now the price is probably scheduled to be in the neighborhood of $27,500. The light twin is essentially a Mark 20 with two engines. The prototype is a Mark 20 airframe with two Lycoming 150-hp. engines. Nose of the fuselage is streamlined and a large dorsal fin has been added to improve stability. Prototype will probably make its first flight in March.

Control Change

Only other major change in the airframe is removal of the Mark 20 fuel tanks in the wings, giving the laminated spruce wing greater strength. Some changes in controls are necessary to accommodate the new powerplants, and it may be necessary to make the rudder larger, although the vertical stabilizer is expected to remain the same size as the standard Mark 20 fin.

Mooney plans to give the Mark 22 a range of 1,000 mi. Current plans call for 35-gal. tip tanks and a 15 gal. tank in the rear of each nacelle but determination of center of gravity requirements will effect final fuel tank arrangements.

Mark 22 will have a cruise speed of at least 200 mph., and rate of climb will be in the range of 1,500 fpm. Gross weight will be 3,150 lb. Although the twin prototype is powered with 150-hp. engines, the production Mark 22 will probably have 180 hp. engines. Hoffman believes the Mark 22 will be very attractive to the company flying an executive who wants to cruise at 200 mph. with the safety of two engines. He also cites economical operation and a price tag under $30,000 as great attraction for corporate aircraft operators.

Demonstration flight in the Mark 20A prototype shows a marked improvement in performance over the Mark 20. New engine in the Mark 20A is a Lycoming O-360, and the new powerplant raises cruise speed from the Mark 20's 165 mph. to the 180 mph. range. Only external difference between the two aircraft is a slightly larger airscoop in the Mark 20.

Mark 20A will have a rate of climb of 1,200 fpm. Gross weight will be the same as the Mark 20's 2,450 lb. Range and other performance are about the same as the Mark 20.

CAA Certification

Mark 20A prototype is currently in its Civil Aeronautics Administration certification program. Mooney expects Mark 20A production models to start off the line and be available as soon as certification is completed—probably by next month.

Mooney will build both the Mark 20A and the Mark 20. Theory is that there will be a number of operators who will want to stick to the 150 hp. engine because the 80 octane gas it uses is more widely available than 91 octane required by the 180 hp. engine. Exact ratio of Mark 20As and Mark 20s in the production line will be determined after a sales pattern becomes evident.

Exact price for the Mark 20A has not been set, but it will cost between $1,000 and $1,200 more than the $13,750 Mark 20. A number of relatively minor changes have been made in the Mark 20 to give the 1958 model more sales appeal. These new features will also be on the Mark 20A. New Mark 20 has a shock-mounted instrument panel, and the rear seat has been moved back two inches to provide more leg room for passengers. New paint has also been added.

An access panel has been added on the left side of the fuselage behind the cabin for easy inspection and maintenance of powerpacks and other equipment for electronic systems. The airplane also has a new 33 amp. battery and 35 amp. generator to handle heavier radio equipment.

Stable Production

Mooney's $1 million sales year represents an upturn in company fortunes after some lean years. Hoffman and President Hal Rachal took over management of the company in 1954. Development of the Mark 20 was completed and sales have been growing each year since 1955, although a series of reverses kept the company's financial picture pretty dark until the 1957 fiscal year. Production rate is now stabilized at one airplane every three working days, but this will be stepped up to one every two days this spring, and by summer the assembly line is scheduled to produce an airplane every day.

Mooney produced about 90 airplanes in the last fiscal year and sold over a hundred. The extra aircraft came from a backlog that had piled up, but the company has worked this down to the point where it now has only the normal backlog of eight to ten aircraft on hand. Expansion of production facilities has been planned several steps to accommodate higher volume and new aircraft. A separate building for metalworking has been built, and a new building will be constructed to handle painting functions.

In the present production facility, a second floor will be extended over the assembly area to provide more assembly room on ground floor. When the Mark 22 goes into production, or when Mark 20 production exceeds two a day, Mooney will build long sheds for assembly work only, and the present building will be used for sub-assembly working.

To provide the sales organization to merchandise Mooney's new aircraft, Norman Hoffman has spent the past year building a sales program practically from the ground up. During 1957, sales manager R. S. Martin was hired, and two sales representatives were appointed to cover the U. S. on a regional basis.

Sales rep W. R. Mullin operates out of Midland, Tex. and covers the country from the plains states out to the West Coast. J. Miller covers the midwest and the Great Lakes region. Both travel extensively, giving dealers and distributors factory sales help and recruiting new dealers to handle the Mooney aircraft.

Mooney has 35 dealers and distributors in the U. S. and has distributors in South America, Australia, Europe, South Africa, Mexico and Canada. Export sales are currently 8-10% of total volume. A third sales representative will be added to the organization when William Wyatt finishes his training. Wyatt recently made two attempts to fly nonstop between Galveston, Tex. and Rome in a Mark 20. He turned back on the first flight, but he and his overloaded Mark 20 flew 4,957 mi. on the second flight before ditching off the coast of Spain.

When he ditched, due to bad weather and icing conditions, Wyatt had been in the air 37 hours and still had enough fuel to reach Rome. After ditching, the Mark 20 floated easily without the aid of the extra tanks in the cabin, and it was towed ashore by a fishing boat.

New Sales Programs

In addition to its new sales organization, the company is introducing two new sales programs in a drive to enlarge field sales efforts and make its aircraft available to more business operators.

First of these is a new sales representative program designed to supplement efforts of dealers and distributors. Fixed base operators and other organizations which can't take on full-time Mooney sales responsibilities will be commissioned as sales agents to do contact work.

These sales representatives will cooperate with the dealers in their areas, working for a recommended commission of 10% of gross profit. Dealers are expected to recruit the sales representatives in their areas, make flight demonstrations, handle trade-ins and help sales representative close his deal. Hoffman predicts that Mooney will have 500 sales representatives commissioned within six months.

Second program is a co-op plan for getting businessmen into the Mark 20 if they can't afford to buy one. Under this plan, dealers will sign up business executives for membership fee of $200 a year and dues are $15 a month. These members will be able to fly a fully-equipped Mark 20 for $10 an hour, compared with normal hourly rate of the Mark 20 of $20. The manufacturer figures that under this plan, it would cost a member nine cents a mile to travel even if he only flies 100 hours a year. Estimating operating cost and income for dealers on the basis of a minimum of ten members each averaging 60 hours a year, Mooney figures a dealer could make a profit of $5.16 per flying hour for each aircraft on the basis of 600 hours flown per year.

Renegotiators Ordered Industry To Refund $33.6 Million in '57

Washington—Renegotiation Board in Fiscal 1957 found eight U. S. airframe manufacturers holding $33.6 million in excess profit on renegotiable sales of $3,865,000,000. All of the refund orders have been appealed to the tax court.

The Board's determinations were released in its annual report last week without identifying the companies involved. The report appeared in the midst of signs that the new Congress, convening next month, will face a heated demand for review of the Renegotiation Act.

Critics, stimulated to a great degree by experiences of the aircraft industry, are calling for re-examination of the law. Major change sought will be a firm formula for determining whether or not profits are excessive.

Spurring interest at this time is the fast transition now under way from manned aircraft to guided missiles. A USAF contract expert pointed out to Aviation Week that the military services, buying conventional aircraft for 40 years, have almost no experience with missile production contracts.

In general, this movement into a new field will complicate the job of cost estimating and tend to make the Defense Department more conservative in its attitude toward the second guess provided by the Renegotiation Act.

Industry Protests

Despite loud protests from industry, it is not expected that government procurement officials will lend support to any drastic change in the situation.

On the other hand, it is recognized that more weight must be given to the virtues of the fixed-price-with-incentive contract. In this case, USAF has been working away from the cost-plus-fixed-fee arrangement. Contractors are being encouraged to sign incentive-type deals with the assurance that they will be rewarded for good performance.

William M. Allen, president of Boeing Airplane Co., says claims against his company by the Renegotiation Board would take back earnings al-

ready given as an incentive for superior performance.

"We were able," Allen says, "to produce at less than estimated cost at great savings to the Government.

"A large part of the amount the company received for achieving a better than anticipated result is now reclaimed by the government under the Renegotiation Act.

Halts Incentive

"I submit that there is no surer way to kill incentive than to have one branch of the government offer a contractor increased earnings for superior performance and then have another branch of the government take these earnings away several years later."

Allen called for amendment or repeal of the law, charging that it is harmful to our security.

Rep. William E. Hess, (Rep.-Ohio), ranking minority member of the House Armed Services Committee, says he does not believe the Renegotiation Act was intended to reclaim earnings that were given as a reward for substantial cost reductions.

Hess also cites the long delay—as much as four years—in redetermination proceedings. He says the criticisms call for careful study and indicates that he will press for action in the new congressional year.

The Board's annual report makes it clear that the aircraft industry is a prime target in renegotiation actions.

During the fiscal year ended June 30, there were 395 determinations of excessive profits. Of these, 337 resulted in bilateral agreements between the Board and the contractor; the other 58 in unilateral orders that money be refunded. Eight of these orders were given to aircraft companies.

The airframe companies were found to have 67% of the excess profits with the other 33% split among the 50 orders given to firms outside the airframe industry. In dollar value, the $33.6 million demanded from eight aircraft companies compares with $16.7 million sought from 50 companies in other fields.

Target of Criticism

There is some feeling in the Pentagon that recent criticism of the Board is the result not of the law itself but of the way it is currently being administered. There are charges that the Board is nit-picking, that it puts too much weight on a company's net worth and that it too seldom pays attention to an outstanding production job.

SIKORSKY S-62, shown here in artist's conception, has flying boat hull, turbine engine. It uses many S-55 components.

Sikorsky's New S-62 to Use S-55 Parts

Stratford, Conn.—Gas turbine powered, helicopter with a flying boat hull and using proven, long-life parts from the S-55 is under construction by Sikorsky Aircraft Division of United Aircraft Corp. and will make its first flight in the spring of 1958.

The new helicopter, designated the S-62, uses all rotor blades, main and tail rotor heads, main, intermediate, and tail gear boxes, shafting, tail rotor pylons and portions of the flight control and hydraulic systems from the S-55. Incorporating these assemblies with a long service life into the S-62 is a major step towards reducing the parts replacement cost which is the major expenditure in the cost of operating rotary wing aircraft.

General Electric T58 gas turbine powerplant is primarily responsible for the great performance advantage that the S-62 will have over the S-55. The S-62 will be 700 lb. lighter than the older S-55 and will have a 700 lb. greater payload under all flight conditions. The S-62 will also have 230 more horsepower available for high altitude and hot weather flight and full power will be available up to 17,000 ft.

The flying boat hull of the S-62 will eliminate the need for emergency flotation gear and will be an additional performance boon to commercial operators. Roll and pitch stability on the water is provided by two floats which are placed forward and away from the watertight fuselage.

Configuration is similar to the S-61 (AW Dec. 23, p. 15). The twin engine S-61 is a Navy project, designated the HSS-2.

President's Claim on Re-Entry Apparently Based on Single Shot

Washington—President Eisenhower's claim in his Nov. 7 "chins-up" speech that Army had solved the re-entry problem (AW Nov. 25, p. 25) apparently was based on only one successful test firing of a scale model, according to testimony by Maj. Gen. John B. Medaris, commander of the Army Ballistic Missile Center, before the Senate Preparedness Investigation Subcommittee.

Highly publicized Jupiter C test vehicle which traveled some 3,000 mi. a year ago did not contain a scaled-down Jupiter nose cone, Medaris said.

Only two flights did carry test nose cones, and only one of these was recovered. It was the one displayed in the President's office during the Nov. 7 telecast.

"(There were) two re-entry flights in the head configuration, nose cone configuration, both intended for recovery," Medaris said. "The first was not recovered. It was outside the area where recovery had been fully prepared for due to deviation in the direction when it finally took off with the last three stages.

"And, although we knew it lived and came through and got into the water in good shape, nobody could get to it in time to recover it. Actually, we believe the sharks got the balloon, as a matter of fact, because a number of them we found around the second one when we got to that."

Second test "fully satisfied conditions of the initial test for the re-entry solution which we had believed would work in connection with the Jupiter program," Maj. Gen. Medaris said.

"In view of the fact that we were shortly going to fly full-scale Jupiter nose cones with this re-entry protection, we could see no further purpose in the re-entry test program, so the balance of it was canceled and the hardware was put on the shelf."

This "hardware"—a number of Jupiter C test vehicles—now will be used in Army's satellite launching program.

Employment Decline

Washington—Full impact of defense spending ceilings on aircraft industry employment finally is being reflected in government statistics. Total drop from the peak last April to the end of October was 61,100, according to preliminary Bureau of Labor Statistics figures.

Total for April was 909,100—an all-time high that put the aircraft and parts field well ahead as the country's largest manufacturing industry. Preliminary total for October was 848,000. This was a drop of 19,500 from the previous month.

Production employes declined 52,200, from the April level of 601,600 to 549,400 in October. Average weekly earnings declined $3.28 a week, from $99.12 last April to $95.84 in October. Average work week declined from 42 hours to 40.1. Average hourly earnings rose from $2.36 in April to $2.39 in October, according to the Bureau.

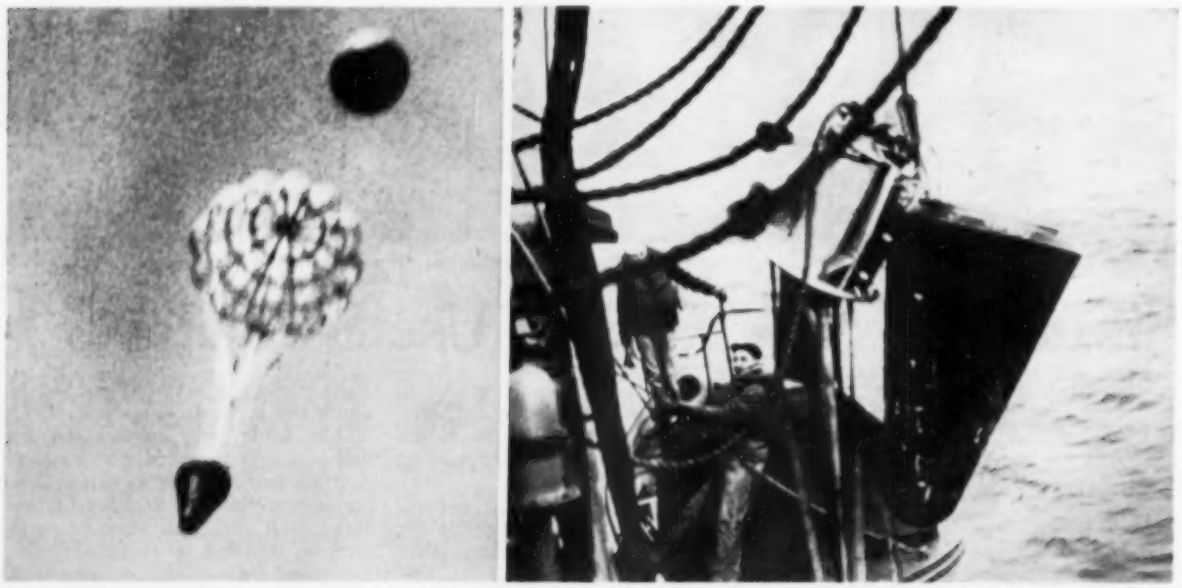
Navy Orders F8U-2 To Go Into Production

Chance Vought Aircraft will produce the F8U-2 and continue production of the F8U-1 Crusader under $200 million Navy contract.

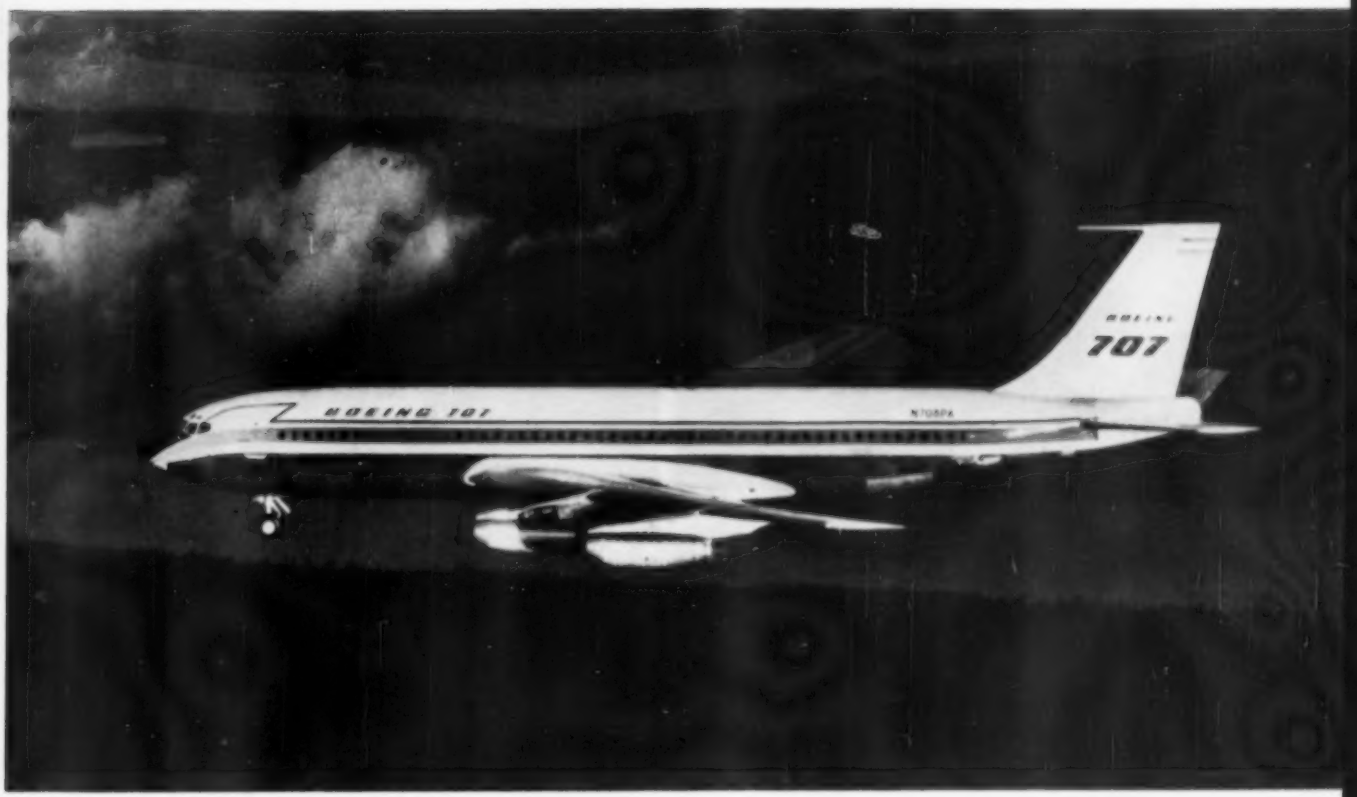
The F8U-2 will be equipped with the new Pratt & Whitney J57-P16 engine. Additionally, the F8U-2 will have an improved fire control system and greater radar capabilities. It will carry the infrared homing Sidewinder missile mounted externally, as the F8U-1 does, along with cannon and 2.75 rockets.

In configuration, the F8U-2 will closely resemble the original Crusader but will have two fixed low aspect ratio ventral fins mounted under the tail section and two afterburner airscoops mounted on the tail cone above the slab horizontal tail.

Like the F8U-1, the new Crusader will retain the variable position wing. The new radar equipment in the F8U-2 is scheduled to be incorporated in the F8U-1.



NOSE CONE recovery system developed by Cook Electric Co. was contained in nose cone of Army Jupiter C IRBM launched from Air Force Missile Test Center, Florida, in August. Recovery system is designed to decelerate the nose cone to 100 fps., support it in water for up to 48 hrs. and provide means for locating nose cone in Atlantic Ocean test area. Cook system, the company said, is designed to perform these functions by causing nose cone to glow, expel a parachute and eject and inflate a balloon (left), eject and explode bombs, emit radio signals, light a flashing beacon, mark landing and spread shark repellent to facilitate recovery (right).

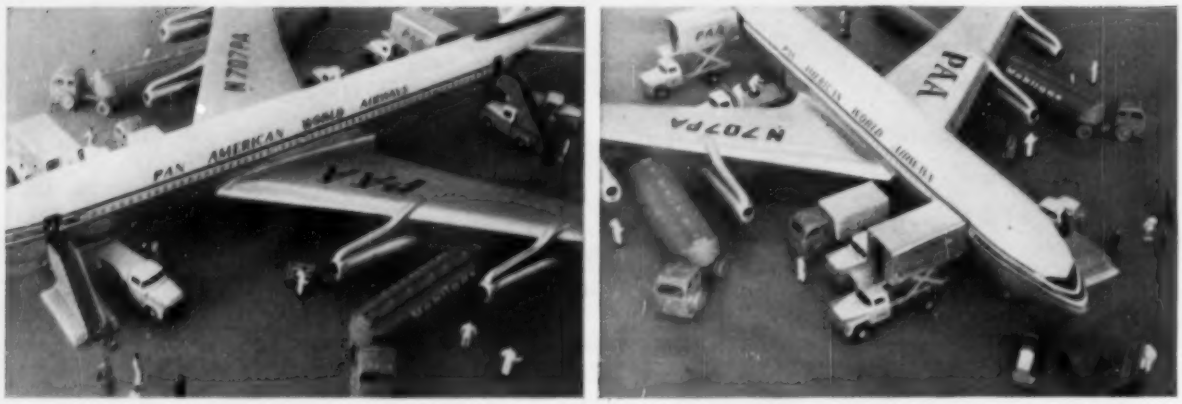


First Production Boeing 707 Makes Initial Flight

Boeing 707 Stratoliner became the first U.S. production jet transport to fly when it took off from Renton, Wash., Municipal Airport and flew five miles to Boeing Field at Seattle. The flight was limited to seven minutes because of unfavorable weather.

Piloting the aircraft was A. M. Johnson, Boeing chief of flight test. Copilot was Senior Test Pilot J. R. Gannett and flight engineer was Senior Test Pilot T. J. Layne. Visible in the photographs are the sound suppressors (AW Dec. 16, p. 79) fitted to the Pratt & Whitney J57 turbojet engines. Boeing currently has 162 orders for 707 from 14 airlines.

The second production 707 is nearing completion at the Boeing plant at Renton. Wearing the colors of Pan American Airways, it is scheduled to be moved out of the factory early in 1958.



EQUIPMENT surrounding Pan American Boeing 707 model represents items needed on ramp during initial operations. Some differences will appear in actual hardware. In picture at right, items clockwise from nose to tail left side, are tow tug, power unit, galley truck, baggage truck, air conditioning truck, fuel truck, baggage truck, galley truck. In left picture, items clockwise from tail to nose right side, are toilet service truck, self-propelled loading stairs, fuel truck, start cart, water service truck, loading stairs.

Flexibility Governs PanAm Jet Planning

Present outlook is for assignment of Pan American's first Boeing 707-121s for transatlantic operation.

By Glenn Garrison

New York—Pan American World Airways is getting down to the practical details of this country's first commercial jet flights, which the airline expects to operate from New York International Airport late next year.

While the decision is not yet completely firm, present plans call for assignment of Pan American's first jets to the Atlantic Division for transatlantic operation. Six Boeing 707-121s are involved in the first phase of the delivery cycle, which will cover about one year.

Operating Questions

Some operational question marks remain at Idlewild, where most jets at present noise levels are still officially unwelcome. But initial operations probably will be handled as follows:

• **Departures** will leave from the airport's ramshackle old terminal building, now supplemented by the new $30 million International Arrival and Airline Wing Buildings (AW Dec. 21, p. 81). Depending on Port of New York Authority approval, the jets will start their engines at the gate and taxi out. Otherwise, they will be towed across the ramp and taxi out from there.

• **Arrivals** requiring federal clearance will come into the International Arrival Building under their own power, if the Port Authority permits, or will be towed the final few hundred feet to their gates. Most of these planes will taxi, after unloading, to Pan American's hangar for servicing.

Completion of the airline's $8 million individual passenger terminal at Idlewild (AW April 22, p. 117), now scheduled for March, 1959, will end all operations from the old terminal building. Jets will taxi in, be towed from gates in the Pan American terminal.

Combination of present ground equipment and new items now under development will be used in handling the jets, which pose some unique problems in this department.

Pan American would like to taxi in and out of the present terminal during initial operations, according to Randall W. Kirk, manager of ground operations for the Atlantic Division. The airline shares with Trans World Airlines a wooden frame finger which extends out from the terminal building, with the farthest gate position about 300 ft. from the main building. The finger is not soundproof or blastproof, but with the few jet schedules involved in initial operation, Kirk believes careful monitoring of each flight will present interference with other ramp operations. Only the outboard gate would be used for jets.

If the Port Authority doesn't agree, departing jets will be towed across the ramp, wait there for air traffic control clearance, and then fire up and taxi out. Same alternatives, of course, apply to jets coming in to the gate position.

Procedure at the arrival building may depend on which gates are available to the jets. Kirk feels that the gates farthest from the building would be suitable for operation without towing. Again, actual use will depend on what the Port Authority decides.

Ramp Approach

When the Pan American terminal comes into use, present plans call for a straight-in taxi procedure. There are no fingers in the proposed building, which features an umbrella-like cantilever roof with a 110-ft. overhang around its circular structure. According to Kirk, the jets will be practically coasting at low power as they come straight in under the overhang to their gates. Thus no serious noise or blast problems should be involved coming in, although the roof precludes engine start and taxi out at higher power requirements. So towing will be necessary on departure.

A major question mark in ground operations is the amount of silencing that will be required in maintenance areas, Kirk told AVIATION WEEK. Degree of silencing needed, and when and where it will have to be used, is not yet clear.

Pan American is now running audiometric tests on its ramp and maintenance personnel so checks can be made of possible noise effect on hearing. The airline plans to use ear plugs and helmets for protection of these people.

Many items of ground equipment now in use will serve the initial jet phase, Kirk pointed out. Examples are self-propelled loading steps, several units of which Pan American now uses at Idlewild; and some tugs which will suffice in hangar areas. But new items will

be required, among them:

• **Bigger tractors** for towing. They will provide higher draw-bar pull than current types. Pan American plans to order by Jan. 1 a light duty tractor of 15,000 lb. pull and a heavy duty tractor with 24,000 lb. pull.

• **Special external** power units. Unlike piston planes, jets will require a source of external power for basic needs like radios and lights whenever engines are shut down. Such power will be required on even a short tow away from the terminal building. The airline plans to use 10 kva. power packs carried on the towing tugs for such purposes. For heavy duty requirements, as during servicing of aircraft, a 60 kva. self-propelled diesel unit will be used.

During servicing, galley equipment will be pre-heated, with ovens turned on before engines are started. More than 12 kva. of power will be used by the galley equipment, Kirk said. Pan American plans to install additional galley units rather than increase the size of present equipment. The Boeings will contain four galley units, installed at two locations in pairs.

• **Engine starters.** Pan American is developing a start cart using 3,600 lb. regulated pressure storage bottles. Prototype of the start cart has been built and is now in Seattle for testing on a Pan American 707. The airline has rejected the proposed gas turbine type of engine starter, Kirk said, as too noisy and expensive.

• **Fueling.** Hydrant fueling will be provided at Pan American's terminal, but trucks must be used initially for such fuel serving as may be required at the ramp of the old terminal. The airline has few quick turnaround or transit flights at Idlewild, so most fueling can be done at the hangar or at off-ramp parking areas.

Runway Lengths

Runways at all mainline terminals served in the first phase of Pan American's jet operation will be adequate, Kirk said. As far as Idlewild is concerned, Pan American has been assured by the Port Authority that whatever necessary will be done to provide an adequate runway for the small Boeing, which the airline estimates will need 9,500 ft. for takeoff at a gross weight of 238,000 lb. This is without thrust reversers, which the airline hopes will be in use for initial operations.

This typical flight carries a payload of 32,700 lb., including 121 passengers and their baggage and 4,700 lb. of cargo. Landing weight is 164,500 lb. with 16,000 lb. of reserve fuel. Figures are based on standard day temperatures.

Pan American may not attempt transatlantic nonstops with its first jets. As with present day equipment, this will depend on payload requirements in turn based on configuration. The all-first-class Stratocruisers flown by the airline, for example, now make it eastbound to London nonstop about 87% of the time, according to Kirk. Whether the first jets will be used in first class service, mixed configuration, or tourist service is still not definite, Kirk said.

Smaller Jets

The second phase of Pan American's jet program, involving 17 Boeing 707-321s and 21 Douglas DC-8s, is expected to begin around the end of 1959. The airline expects to have learned a lot by then from operation of the smaller jets.

A number of question marks remain as to adequacy of terminal facilities at many points for the second phase, Kirk said. In the United States, the situation will be good if those airports planning expansion carry out their programs. Abroad, however, inadequacies will exist at several major gateways if improvements are not planned and carried out.

Hopeful development, according to Kirk, is the fact that foreign-flag carriers have bought jets in quantity and terminals should be provided for them.

Late-Year Traffic Trend Decline Indicates Profit Drop for 1958

By L. L. Doty

Washington—Sudden late-year slowdown in normal airline traffic trends points to an even deeper profit depression for 1958 than that experienced during 1957 when earnings fell to their lowest level in seven years.

Domestic trunkline carriers this year earned an estimated $25.4 million as compared with a $57 million net profit reported in 1956. This represents a 56% drop—slightly more than the 50% decline forecast last spring by AVIATION WEEK (AW May 13, p. 39).

Unless the airlines are provided some relief in the form of fare increases, it appears the industry will experience a 20% cut in net profits during 1958. This forecast is based upon an expected upswing in the general economy. Most observers cite the present economic recession as the chief reason behind the poor showing in traffic gains during the past four months of the year.

However, if the present mild recession continues without relief until late 1958, as the more pessimistic economists are forecasting, the airlines will run into real trouble next year. A prolonged tight travel market, an inevitable reaction to a soft economy, could force a number of airlines into the red in 1958.

Domestic trunkline business continued to climb during 1957, but a marked dip in the rate of traffic increases during the last four months is leading some observers to fear the industry's historic growth pattern may be headed for a temporary plateau in early 1958. If such is the case, load factors will suffer a severe drop since available seat-miles, which climbed over 18% in 1957, will be hiked even higher in 1958 when at least 84 new aircraft will be added to present fleets.

Load factors, which held to an average 63% for the 12 months ending in August, reacted sharply to the skidding traffic trends and dipped to a low of 55% in November.

Hardest hit in the dwindling travel market have been the railroad and bus lines which this month experienced a decided acceleration in the rate of traffic declines evident this year.

Domestic airlines enjoyed a 12.8% gain in revenue ton-miles in 1957 com-

1957 Domestic Trunk Airlines Revenue*

(000 OMITTED)

OPERATING REVENUES	1957	1956	% INCREASE
Passenger	$1,298,684	$1,142,201	13.7
U. S. Mail	34,018	31,594	7.7
Express	15,175	18,102	−16.2
Freight	51,631	42,172	22.4
Other	32,751	26,153	25.2
Operating Revenues	1,432,259	1,260,222	13.7
Public Service Revenues	1,127	2,609	−56.8
Total Revenues	1,433,386	1,262,831	13.5
Operating Expenses	1,385,782	1,162,231	19.2
Net Operating Income	47,604	100,600	−52.7
Net Profit	$25,373	$57,712	−56.0

(*Based on nine months actual, last three months estimated)

Scheduled Airlines' Estimated Traffic, 1957

(000 OMITTED)

TOTAL SCHEDULED AIRLINE INDUSTRY	1957	1956	% INCREASE
Revenue Passenger-Miles	31,522,054	27,615,179	14.1
U. S. Mail Ton-Miles	161,720	152,503	6.0
Express Ton-Miles	47,712	52,666	−9.4
Freight Ton-Miles*	540,815	451,178	19.9
Revenue Ton-Miles	4,063,955	3,547,352	14.6
DOMESTIC TRUNK			
Revenue Passenger-Miles	24,716,465	21,643,141	14.2
U. S. Mail Ton-Miles	97,751	91,686	6.6
Express Ton-Miles	43,481	49,711	−12.5
Freight Ton-Miles	233,352	190,595	22.4
Revenue Ton-Miles	2,763,145	2,452,469	12.7
LOCAL SERVICE			
Revenue Passenger-Miles	756,511	633,224	19.5
U. S. Mail Ton-Miles	1,639	1,570	4.4
Express Ton-Miles	1,652	1,687	−2.1
Freight Ton-Miles	2,153	1,624	32.6
Revenue Ton-Miles	79,257	66,534	19.1
HELICOPTER			
Revenue Passenger-Miles	3,420	1,571	117.7
U. S. Mail Ton-Miles	95	91	4.4
Express Ton-Miles	35	34	2.9
Freight Ton-Miles	15	7	114.3
Revenue Ton-Miles	479	277	72.9
TOTAL DOMESTIC INDUSTRY			
Revenue Passenger-Miles	25,476,396	22,277,936	14.4
U. S. Mail Ton-Miles	99,485	93,347	6.6
Express Ton-Miles	45,168	51,432	−12.2
Freight Ton-Miles	235,520	192,226	22.5
Revenue Ton-Miles	2,842,881	2,519,280	12.8
INTERNATIONAL			
Revenue Passenger-Miles	5,804,202	5,116,448	13.4
U. S. Mail Ton-Miles	57,408	55,153	4.1
Cargo Ton-Miles	124,790	109,225	14.3
Revenue Ton-Miles	825,915	728,423	13.4
ALASKAN			
Revenue Passenger-Miles	151,794	136,920	10.9
U. S. Mail Ton-Miles	2,662	2,372	12.2
Cargo Ton-Miles	7,469	7,944	−6.0
Revenue Ton-Miles	34,015	44,696	−23.9
TERRITORIAL			
Revenue Passenger-Miles	89,662	83,875	6.9
U. S. Mail Ton-Miles	67	62	8.1
Cargo Ton-Miles	1,488	1,475	.9
Revenue Ton-Miles	9,087	8,779	3.5
TOTAL INTERNATIONAL & OVERSEAS			
Revenue Passenger-Miles	6,045,658	5,337,243	13.3
U. S. Mail Ton-Miles	60,137	57,587	4.4
Cargo Ton-Miles	133,747	118,644	12.7
Revenue Ton-Miles	869,017	781,898	11.1
ALL CARGO			
U. S. Mail Ton-Miles	2,098	1,569	33.7
Express Ton-Miles	2,544	1,234	106.2
Freight Ton-Miles	171,548	140,308	22.3
Revenue Ton-Miles	352,057	246,174	43.0

(* Includes cargo [express and freight] of Alaskan, international and overseas airlines.)

pared to 1956. Largest increases were made by the helicopter lines with a 73% rise in revenue ton-miles and local service carriers with a 19% increase. Trunk lines showed a 12.7% increase.

The profit squeeze, which first became evident in 1956, is due primarily to mounting expenses estimated to be 19% higher in 1957 than in 1956. Operating revenues climbed an estimated 13.7% in the same period. The year profits failed to climb over the $30 million mark was in 1949 when the domestic carriers earned a net income of $13.4 million.

Passenger-Mile Increase

Revenue passenger-miles of domestic trunklines were up an estimated 14.2% in 1957 over the previous year. This compares favorably with the 14.1% increase recorded in 1956.

The rate of increase, however, dipped abruptly in September when revenue passenger-miles rose only 10% over the same month in 1956 and only 7% in October over October, 1956. A 10% increase was reported in November and, although it is still too early to make an accurate estimate of December's activities, an AVIATION WEEK survey indicates the normal rate of climb in revenue passenger-miles has not been restored.

If the present trend continues, it is possible the airlines will experience an 8-10% traffic increase for the year 1958, with a slightly less percentage increase during the first quarter of the year, to give the carriers a slow start in strengthening profit margins. Average traffic gain between 1951 and 1956 was 16%.

The problem will be intensified throughout the year because of the grim outlook for any curtailment of expenses. Fuel costs are up about 15% and labor can be expected to start a new round of demands for more fringe benefits and higher wage levels. 1958 could be the year unions will make their first bids for a 36 hour week.

Traffic Competition

Competition for traffic on major routes will become keener, and expenses resulting from such new methods as electronic ticketing and reservation techniques to meet the competitive challenge can be expected to rise. Automation will not reduce the labor force.

Advertising budgets are not likely to suffer during 1958 unless the carriers' financial condition becomes critical. Promotional dollars will be watched carefully.

Of great concern to airline executives seeking means of raising capital is the sharp decline in airline common stock prices—a direct result of the profit pinch. Market value of airline stocks plummeted from about $600

million as of June 28 to approximately $433 million as of Dec. 19. Since the industry is planning equity sales totaling some $400 million during the next few years, the decline means airlines will be forced to raise an amount of equity capital almost equal to their net assets less depreciation.

Investors Wary

Investors are shying away from airline stocks and the low rate of return of most stocks together with erratic dividend programs will probably hold airline stocks close to their present low market price level through most of 1958. As a result, any earlier plans at equity financing probably will be postponed beyond 1958.

When stock book value is higher than market price—now true of airline stocks—issuance of additional shares means a further reduction in book value and a deeper cut into earnings per share. However, both book value and earnings tend to climb in equity financing when the ratio of book value to market value is favorable, since it takes fewer additional shares to raise the desired amount of capital.

At present, it does not appear likely that any domestic trunkline carrier in 1958 will be forced to follow Capital Airlines' action in requesting a return to subsidy (AW Nov. 11, p. 39).

Although the Civil Aeronautics Board is not expected to react sympathetically to the petition, bankers will watch the proceedings carefully. Most bankers will admit that the airline industry's present credit standing is as high as it is because of the protection against loan default implicit in subsidy clauses of the Civil Aeronautics Act of 1938.

Freight Gains

Air freight gained substantially in 1957 and, although freight ton-miles experienced a slowdown in October similar to the passenger traffic drop, prospects for increased activities in the freight field next year seem good.

Both United and American have expanded their all-cargo schedules and will strengthen their positions in the cargo field with an increased promotional effort in 1958 to help expand the market. Generally, the scheduled airline industry showed a gain of 19.9% in freight ton-miles during 1957 as compared with 1956. Flying Tiger Line is estimating a 52% in gross revenues in 1957 over 1956.

Widening use of air freight by distributors is indicated by the 32.6% increase in freight ton-miles registered by the local service carriers. This marked increase suggests that shippers are turning to the airlines for direct point-to-point air cargo service to-and-from smaller communities that are enjoying new industrial output as a result of a recent trend toward dispersal of manufacturing facilities.

Local Service Increase

The 19.5% climb in revenue passenger-miles on local service carriers also suggests greater use by travelers of the "feeder" type of service in lieu of connecting bus or train service. However, most local service airline heads warn that subsidy-free operations cannot be expected until the money-losing DC-3 is retired from scheduled service.

As to traffic, local service carriers can expect an increase during 1958 similar to that experienced in 1957 despite the expected slow-down in domestic trunkline traffic flow. It is now apparent that the smaller carriers are in the midst of a healthy growth pattern that should offset any general traffic decline.

Biggest job ahead in 1958 is to demonstrate to the Civil Aeronautics Board that a fare increase is an essential element in the financing of the industry's jet program and that a postponement in the increase of available seat-miles is not a healthy means of rescuing declining load factors.

It is possible the Board may challenge the need for more seat-miles, which will be made available through the increased speeds and greater capacity of the turbine powered transports, at a time when traffic volume appears to be leveling off. The logic of such a challenge may be hard to refute. But, as one airline official told AVIATION WEEK, "we can't afford to follow a Sputnik-type of event in air transportation to shove the U. S. airline industry into a second place in international operations."

CAA Expands Aeronautical Center As Air Navigation Program Grows

By Craig Lewis

Oklahoma City—Aeronautical Center is being expanded here to give Civil Aeronautics Administration the work force it will need to handle its burgeoning air navigation facilities program.

In a $13 million expansion program, the CAA Center is getting the facilities it must have to train the air traffic controllers, engineers, inspectors and other personnel who will be a key factor in the establishment, maintenance and operation of the $810 million worth of air navigation facilities CAA plans to build in the next six years.

Construction program here is part of the generally intensified effort of the CAA over the past two years to prepare the nation's airways to cope with present traffic problems and meet the coming complexities of jet operations.

New Aeronautical Center is scheduled for completion next summer, and its director, Fred M. Lanter, says the center's training program has been planned to provide the work force for the various elements of CAA's airways program when it is needed.

Stay in Oklahoma City

The building program here represents a decision by CAA to stay in centrally-located Oklahoma City and consolidate a number of training, maintenance and housekeeping functions in one modern plant.

CAA first opened its Aeronautical Center here at Will Rogers Field in 1946 when a number of facilities were consolidated in a group of war surplus buildings rented from the city. By 1954, the agency had expanded into 128 temporary type structures, and the increasing deterioration of these buildings called for construction of new facilities or a move to a new location.

Conferences with city officials produced a plan to set up a trust which would finance new facilities and rent them to CAA. The Oklahoma City Airport Trust sold bonds to build the center and is renting it to CAA on a 25 year lease with renewal options.

Total Cost

Cost of the new center is $13,665,000 including financing expense. Bonds will be retired at the end of 25 years, and CAA will have the option of renewing its lease at a lower rate. Oklahoma City will retain ownership.

When completed, the new facility will include eight new buildings ranging in size from 2,870 sq. ft. radar antenna laboratory to a 651,000 sq. ft. warehouse and shop building. Activities will center around a three-story headquarters building which will house administrative offices, general classrooms, cafeteria and auditorium.

About half the training work done at the aeronautical center is in facilities engineering. Here engineers and technicians are trained in the special techniques involved in the installation and maintenance of air navigation facilities. Students are trained in four courses covering 45 different subjects relating to CAA equipment. School offers 13 correspondence courses to prepare students for training at the center and to keep field engineers up to date.

Air Navigation Facilities Laboratory used in this program is the largest of

DRAWING of aeronautical center, Civil Aeronautics Administration, Oklahoma City, Okla.

five laboratories at the center. It covers 69,100 sq. ft. and can be expanded to twice this size. This extra room may have to be added soon since the present student load equals the capacity of the laboratory, and next year it is expected to be double the present capacity.

Laboratory Equipment

Facilities laboratory uses actual equipment for training. It is designed to handle heavy electrical loads, including provision for any navigation and landing aids that might be developed in the future.

Instructors in facilities engineering, as well as in other fields, must be recruited from CAA ranks because their skills can't be found elsewhere. Out of a total work force of 1,200 at the center, between 300 and 350 are instructors. Recruiting of these instructors has been difficult because of the general shortage of trained CAA personnel. Often it's difficult to decide whether a man is needed worse in the field as an engineer or at the center as an instructor.

In the facilities field, as well as in other departments at the center, CAA trains civil aviation personnel from several foreign countries through State Department programs.

Next heaviest training load is the air traffic controller program. This segment comprises about 40% of total student force, and 1,900 controllers are scheduled for training in the current fiscal year. Student load is expected to jump to 3,900 in Fiscal 1959.

Air Traffic Control Laboratory was finished and occupied in September. The building contains seven classrooms equipped with mock control towers and air route traffic control center. These areas are also designed with flexible power sources to permit adjustments to future traffic control equipment.

Tower mockup includes a radar shack equipped with radar simulators, and it looks out on a mockup of the Will Rogers Field runway layout. A set of instruments is provided for a pilot to simulate aircraft movements in the area, and the lighting is designed to provide all gradations between dawn and dusk.

ARTC mockup includes standard strip-posting and radar facilities. Problems are set up in an adjoining room which contains instrumentation to send signals simulating aircraft movements to the training mockup.

These new traffic control training facilities will permit CAA to resume its former practice of training controllers in a ten week course. Because of present shortages, controllers get only a relatively brief indoctrination before they are sent out to get the bulk of their training on the job. This system tends to produce variants in control techniques in different parts of the country. More extensive training of controllers in one spot will improve standardization of techniques.

Along with the program of instruction for new controllers and communication specialists the Aeronautical Center provides training for foreign nationals and gives condensed two week courses on basic fundamentals for people from the military services, commercial aviation and other CAA units.

Safety Inspectors

Training of CAA safety inspectors is done by the Flight Operations and Airworthiness Division. This program covers indoctrination of new inspectors and engineers, standardization training to promote uniform application of regulations, qualification of CAA personnel in new skills—such as jet flying and refresher training to maintain skills.

For flight instruction, CAA uses several aircraft from small single-engine types to C-54s, F-80s and a T-33. For ground training, the department has a jet instrument trainer and a Boeing Stratocruiser simulator. A Boeing 707 jet simulator is on order and scheduled for delivery next August. Link trainers are also used.

The Flight Operations and Airworthiness Laboratory, occupied in November, provides 39,900 sq. ft. of space for training in technical aspects of aircraft and their systems. Instruction is given here in aircraft design, construction and maintenance, and in the complexities of electrical-electronics systems and powerplants.

This building houses actual hardware used for familiarization. It has a helicopter, and piston and turbine engines of various types, including the J57 and T56 engines which will power coming airline transports. CAA teaches general turbine engine theory here, and officials say that several airlines have sent personnel to take the course and that the carriers plan to pattern their own training courses after the CAA model.

Flight inspection is another basic function at the Aeronautical Center, and this group occupied its new building last July. Here flight crews are trained for the flying laboratories which inspect the air navigation aids on the federal airways. This group provides both initial and refresher training for CAA and Air Force crews.

In the future, an avionics training section will be set up to instruct technicians working in radio shops on airborne electronic equipment. The flight inspection branch must also provide engineering and overhaul service for the electronic gear used in inspecting airways facilities.

Data Section

New building houses a data processing section which takes information from recorders after inspection flights and checks it to determine whether navigation aids inspected are within acceptable tolerances. Building also has a dust-free room for repair and calibration of precision electronics gear.

Until recently, Flight Inspection used the C-54 and DC-3 for all its inspection work. Now, however, the group has a Convair 440 in service for checking aids at medium altitudes, and four more Convairs will go into this service. For checking aids at high altitudes, flight inspection now has two Martin RB-57A jet aircraft.

Maintenance and operations will be improved with the addition of a third hangar to the two now in service. The new hangar will be 297 ft. long, 176 ft. wide and 42 ft. high, and it will provide three floors of shop and office in the building which form its sides.

Biggest structure in the aeronautical center is the warehouse building which will provide 15 acres of storage area. CAA will operate a central supply depot here for all its facilities in the continental U. S.

Warehouse building will include shops where navigational facilities will be repaired and maintained. A continuous program for modernizing obsolete aids will also operate in this area.

A key service of the Facilities Materiel Division here will be packaging of the new navigation aids ordered by CAA for expansion and modernization of the Federal Airways System.

AERONAVES DE MEXICO'S second Bristol Britannia 302 was delivered to Mexico City on Dec. 17, went into scheduled Mexico City-New York service next day. El Al Israel, BOAC, have started transatlantic Britannia service.

Three Airlines Open Britannia Service

New York—First turbine airliner service on the North Atlantic was inaugurated with a Bristol Britannia 312 on Dec. 19 by British Overseas Airways Corp. Two other airlines now are flying the long-range turboprop plane into New York. El Al Israel began service from Tel Aviv on Dec. 22, and Aeronaves de Mexico flew its first Britannia schedule from Mexico City on Dec. 18.

BOAC's London-New York inaugural made the 3,750-mi. flight nonstop in 12 hr., 40 min. with 40 passengers aboard. Headwinds of 100 mph. slowed the trip, BOAC said. The airline is operating an initial round trip a week in each direction with the Britannia, with scheduled time of 12 hr. westbound and 9 hr., 50 min. eastbound. Configuration is 28 de luxe, 24 first class seats with berths also available.

El Al made a pre-inaugural nonstop proving flight from New York to Tel Aviv Dec. 19 in 14 hr., 57 min. The 5,900-mi. flight averaged 394 mph., El Al reported, with an average tail wind of 40 mph. The flight, carrying 40 passengers, took off with 9,970 gal. of kerosene, consumed 31 tons of the fuel, and landed at Tel Aviv with 660 gal. in reserve, enough for 1 hr. and 10 min. of flying. The Britannia flew at 35,500 ft. during the last five hours of the trip.

El Al flew its first scheduled trip with the plane from Tel Aviv to New York with stops at Paris and London. The Israeli carrier is operating its Britannias in mixed service with 66 tourist and 18 first class seats. Eastbound flights serve London, Paris and Rome in addition to Tel Aviv. Initial frequency is once weekly in each direction, to be increased to two a week in January and three a week in February.

Aeronaves is offering daily Britannia service in each direction between New York and Mexico City. Nonstop scheduled time each way is 5 hr., 30 min. The Mexican airline provides 66 tourist, 28 first class seats on the flights.

Wiring troubles which caused some last-minute delays to the Britannia operators have been corrected, according to Bristol, by replacement of a section of aluminum wiring leading to the engine starter with copper wiring.

The manufacturer also reports success with its fix of the icing troubles which affected the Britannia's Proteus engines in some flight conditions. Modifications involve both multiple ducting and air bleed to free the ducts of ice, Bristol said. A spokesman said the multiple "rabbit warren" ducts alone would solve the icing problem, but the hot air bleed will also be available.

The Bristol spokesman also told Aviation Week that the company expected certification by Civil Aeronautics Administration by the May 1 deadline set by Northeast Airlines to be met without difficulty.

Northeast's Britannias, the spokesman said, are still scheduled for fall, 1958 delivery.

Bristol Aeroplane Co., U.S.A., announced last week plans to open a turbine engine overhaul and repair base at Miami in cooperation with Air Carrier Engine Service, Inc. The facility will be designed primarily as a support operation for Proteus engine users in the U.S. and Caribbean area, but also will be available for operators of other turbine types, Bristol said.

Great Lakes' Recommendations

Washington—Suspension or termination of trunkline service at several points in the Great Lakes area with local service carriers to fill in the void has been recommended by Civil Aeronautics Board's Bureau of Air Operations. North Central and Lake Central airlines were suggested for the major portion of this service.

In a statement of position filed in the Great Lakes Local Service Investigation Case Bureau Counsel James M. Tomlinson recommended that:

- **American Airlines' authority to serve Elkins and Parkersburg, W. Va., should be temporarily suspended and its authority to serve Clarksburg, W. Va., should be terminated.**
- **Capital Airlines should be temporarily suspended at Clarksburg, Morgantown and Wheeling, W. Va.; Erie, Pa.; Cheboygan, Sault Ste. Marie and Traverse City, Mich.**
- **Trans World Airlines should be temporarily suspended at Terre Haute, Ind., and Wheeling, W. Va., and terminated at Morgantown.**

Lake Central Airlines was recommended for routes between Washington/Baltimore and terminals at Columbus and Cincinnati, Ohio, in addition to replacing suspended service at points in Pennsylvania, West Virginia, Ohio, and Indiana.

North Central was recommended for routes from Michigan's Upper Peninsula and southwest Michigan to Chicago and through southeast Michigan to Detroit, plus a Milwaukee-Detroit route. It also was suggested that Ozark Airlines operate a route between Louisville, Frankfort and Cincinnati.

SHORTLINES

► **Allegheny Airlines** reports it has flown more than 71 million passenger-miles in the first 11 months of 1957, an increase of 17% over the same period of last year. Allegheny president Leslie O. Barles says Allegheny should carry more than 450,000 passengers by Jan. 1, a new high for the airline. Since it began passenger services in 1949, Allegheny has carried more than 2,278,000 passengers over 347,652,000 passenger-miles.

► **Braniff Airways** announces that earnings for the first 10 months of 1957 were $1,622,000 as compared with $1,730,000 for the same period of 1956.

► **Eastern Air Lines** has opened a $1 million sales and reservations office on top of the Merchandise Mart in Chicago. The new one-story aluminum and glass structure, which raises the Mart's height to 19 stories, is fully air conditioned and capable of handling close to 400,000 telephone calls a month. The telephone sales section has 64 sales agent's positions in operation.

► **Pan American World Airways** will begin more frequent service to San Juan, Puerto Rico, on Jan. 17 with a new daily first class, nonstop Douglas DC-7B flight and two Douglas DC-6 first class inter-island flights. The DC-7B flight, on a roundtrip basis, will be scheduled to leave New York's International Airport at 9:00 A. M. and arrive at San Juan at 3:20 P. M., both local times, the DC-6 inter-island flight on Friday will operate from New York to San Juan and Antigua; the Saturday flight from New York to San Juan, Martinique, Barbados and Trinidad. Also on Jan. 17, Pan American will accelerate its Miami-San Juan service with a daily round trip DC-6 flight to the Puerto Rican capital.

► **Trans-Australian Airlines'** annual report reports that a record 793,956 paying passengers were carried a total of 16,376,546 mi. in 89,662 flying hours during 1956-57. The Australian carrier's revenue from all sources was up 9.2% over that of the last fiscal year; operating profit was up 7%.

► **Western Air Lines** has announced a record $2,385,860 net income for the first nine months of 1957, equivalent to $2.81 a share based on 848,541 shares of stock outstanding as of Sept. 30. This compares with $2,095,689 net income for the first three quarters of 1956. Thus far this year, Western Air Lines has paid 80 cents a share in cash dividends.

AIRLINE OBSERVER

► Two more sales officials have left Capital Airlines to take positions with Northeast Airlines, bringing the total of resignations within the past three weeks to four. J. O. Urquhart and Maurice M. DeGroff will join Northeast on Jan. 15 in executive capacities. They follow James W. Austin who resigned to become Northeast's president and Nelson Fry who has been named vice president-traffic and sales (AW Dec. 23, p. 28). A fifth member is expected to make a decision to move this week. Meanwhile, Capital named Read Q. Chalfant, the airline's Chicago district sales manager, to replace Austin as director of traffic and sales.

► **Airline employes are violently protesting a new Civil Aeronautics Board directive that substantially reduces the number of persons eligible for free and reduced-rate transportation. In a few cases, protests from field offices have been fired to headquarters over company teletype lines. The Board's ruling now eliminates these categories of persons from free transportation eligibility—retired employes, parents who are not dependents, brothers and sisters not dependents and children over 21 who are not dependents. Unions will back the stand of employes and all airline unions will meet with the Air Transport Assn. at AFL-CIO headquarters in Washington next week to adopt measures designed to defeat the Board's ruling.**

► Watch for an expanded effort by local service airlines to launch major re-equipment programs in 1958. One local service airline president told AVIATION WEEK he estimated subsidy requirements in 1960 will be double today's amount unless the money-losing DC-3 is replaced by that time.

► **Look for a public congressional hearing on the recent shakeup of Civil Aeronautics Administration's press staff (AW Dec. 23, p. 33). Repercussions to the sudden removal of three of the four man staff are growing stronger and have made Administrator James Pyle the target of much criticism. The Senate Post Office and Civil Service Committee is now looking into situation.**

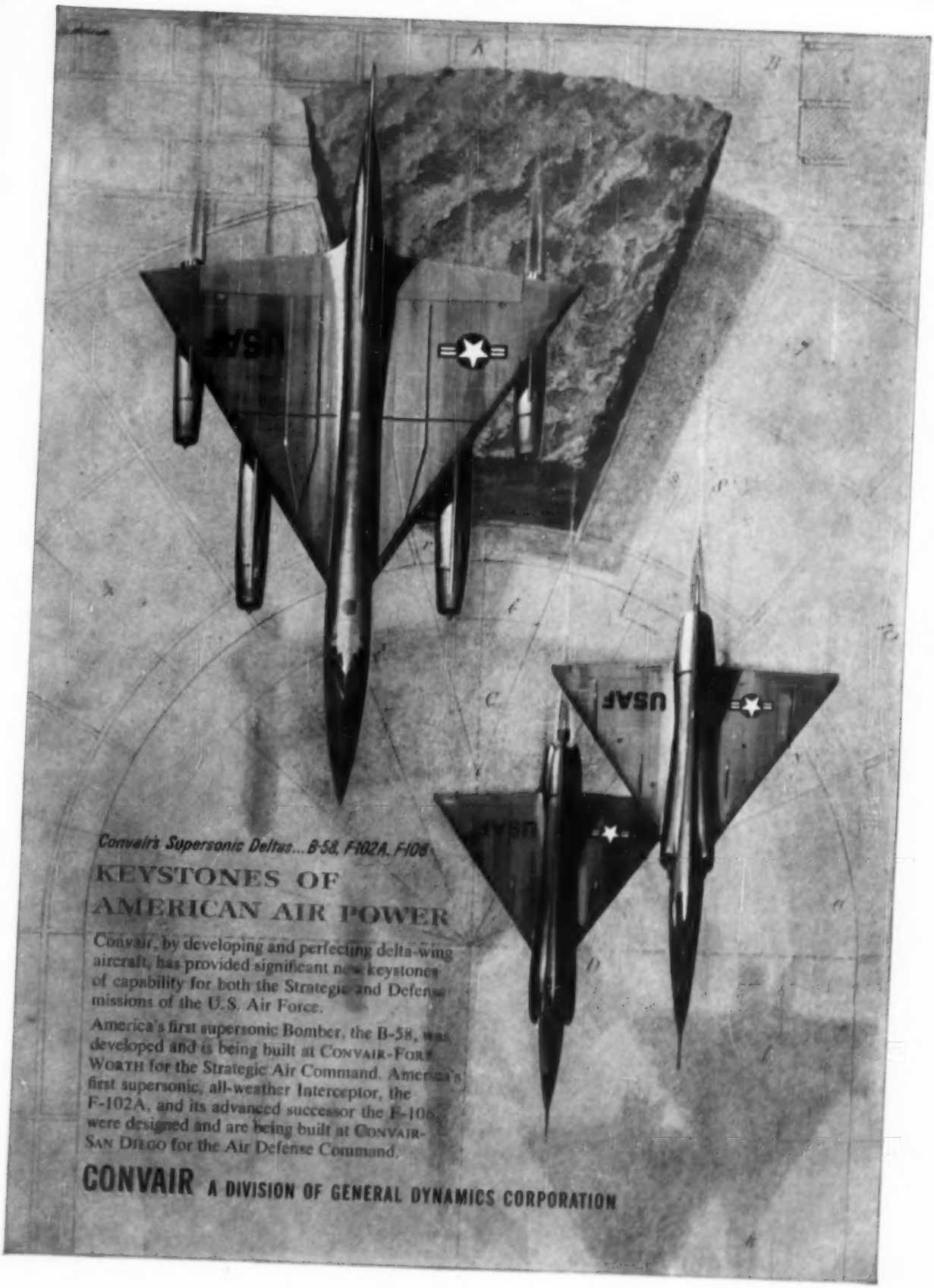
► Fokker may sell India a license to produce the Friendship F-27 turboprop transport since Indian Airlines Corp. is interested in the aircraft as a DC-3 replacement but can make no firm purchase commitments because of a foreign exchange shortage in India. Fokker plans to bring the F-27 to India next month to give the Indian Air Force an opportunity to test it. If the licensing proposal materializes, the Dutch manufacturer will be ready to come in as a technical consultant and perhaps with "some capital."

► **Russia expects to have two of its three new turboprop transports in commercial operation during 1958. Chief Air Marshall Paval Zhugarev said Aeroflot will provide regular service with both the 75-passenger and 100-passenger versions of the four-engine turboprop Ilyushin Il-18 Moskva next year. He added that the Antonov turboprop Ukraina will be ready for airline use "soon." The large Tu-114 Rossiya turboprop transport is still in the early stages of testing and is probably a minimum of four months behind the Moskva in regard to availability for service.**

► Soviet Union and United Kingdom have reached an agreement for the establishment of a bilateral route between London and Moscow via Copenhagen. Russians are expected to operate the route with Tu-104 jet transports; British Overseas Airways will use Viscounts.

► **Air traffic controllers are warning that possible confusion may result from use of dual names on Jeppeson Co., charts covering the New York, Washington, Detroit and Atlanta areas. Controllers say serious misunderstanding can result by controllers using one name for a facility with the users of JEPCO charts using another. The system has been in effect for several months, but controllers claim that the Aeronautical Chart Section of Coast and Geodetic Survey was not made aware of the changed procedure.**

► International Air Transport Assn. is forecasting a 1958 traffic increase of more than 15% on international routes.



Convair's Supersonic Deltas... B-58, F-102A, F-106

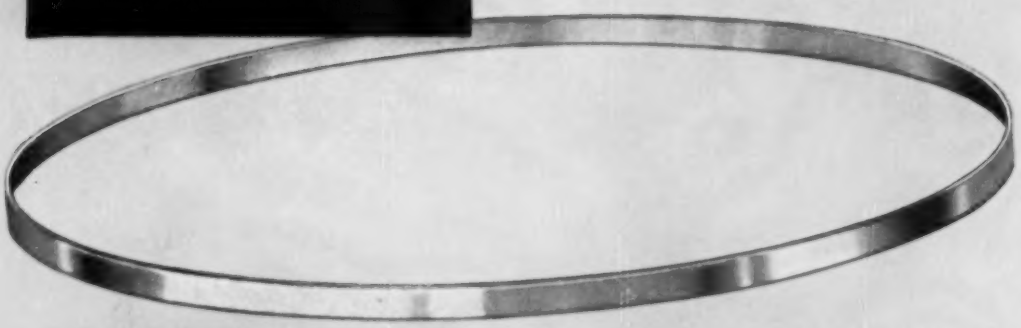
KEYSTONES OF AMERICAN AIR POWER

Convair, by developing and perfecting delta-wing aircraft, has provided significant new keystones of capability for both the Strategic and Defense missions of the U.S. Air Force.

America's first supersonic Bomber, the B-58, was developed and is being built at CONVAIR-FORT WORTH for the Strategic Air Command. America's first supersonic, all-weather Interceptor, the F-102A, and its advanced successor the F-106, were designed and are being built at CONVAIR-SAN DIEGO for the Air Defense Command.

CONVAIR A DIVISION OF GENERAL DYNAMICS CORPORATION

Precision Rings with little or no machining



Today you can purchase precision flash butt-welded rings that require little or no machining to meet your specifications. Made from bar stock of finished gauge, they can be produced to meet the same tolerances as conventionally machined rings. Cost of production and materials of some rings has been reduced as much as 60%. Sizes and materials at present are limited to those bar stocks which can be furnished to precise finished dimensions. However, persistent efforts of American Welding engineers and the producers of finished bars give promise of a widening range of sizes and metals that can be manufactured by precision forming and welding.

This is another example of why you should call American Welding first — if the problem is circular and of metal.

New Products Catalog

Write today for 20-page catalog of circular products which American Welding can form, weld and machine for you.

AMERICAN WELDING

THE AMERICAN WELDING & MANUFACTURING CO.
420 DIETZ ROAD • WARREN, OHIO

Aeroflot Acts Hostile Toward U.S. Carriers

Moscow—Aeroflot, Russia's state-owned airline, is continuing its campaign to try and discredit the privately-owned U. S. air transport industry.

For the third time in recent months, Aeroflot's official organ—Grazhdanskaya Aviatsiya—has made a stinging attack on American carriers. Latest targets are the recent bomb scares and the congressional investigation into the speculation in Northeast Airlines stock prior to the Civil Aeronautics Board's New York-Miami route decision (AW May 6, p. 41).

Previously, the same Soviet publication had criticized U. S. operators for "cruel exploitation" of their employes and for accepting subsidies.

At the same time, Aeroflot is showing some of its own progress to the West. Last week, it inaugurated its first regular jet service to Western Europe with the introduction of twin-jet Tu-104 transports on the route from Moscow to Copenhagen. Russia began jet service late last month between Moscow and Budapest and is now operating proving flights between Prague and Moscow prior to regular service over the Czechoslovak Airlines system.

Now that the Russians are able to display modern aircraft in the form of the Tu-104 twin-turbojet and the Tu-114 four-engine turboprop transports, Aeroflot apparently is ready to extend its operation even further west.

Talks with the British on a bilateral agreement for a reciprocal air route between London and Moscow were held in mid-December.

Last month, the Soviet Union announced it was prepared to open negotiations with the U. S. on an agreement covering direct air service between Russia and the U. S. (AW Nov. 4, p. 41). The subject has not yet been officially broached by the Russian embassy in Washington, although there are no indications that the proposal has been shelved.

American Will Begin Flying Mexico Route

New York—American Airlines plans to inaugurate nonstop service between Chicago and Mexico City on Jan. 5 under terms of the recent Mexico-U.S. bilateral agreement. Daily DC-7 flights in each direction will be operated in dual configuration with 32 first class Mercury seats and 38 seats for Royal Coachman passengers.

Fares will be $114 one way and $216.60 roundtrip for the Mercury accommodations, $76 one way and $152 roundtrip for the Royal Coachman.

COCKPIT VIEWPOINT

By Capt. R. C. Robson

You Take the High Road

Among the "musts" in the aeronautical world today it appears that we must soon develop a traffic control system for handling air transports operating in the neighborhood of 30,000 ft. at speeds near 600 mph. As a matter of fact, more traffic than we suspect is already in this class. Fortunately, the necessity for a system and the magnitude of the problem have already been realized.

So much so in fact, that there appears a need to shout "Whoa—what about the low altitudes?"

It's not so long ago that I remember flying a Waco F into Syracuse, N. Y. (a major terminal to me in those days), and reminding myself to keep a sharp lookout for airliners. My vigilance was soon rewarded—but not in the direction I had expected. There was a DC-3 cruising below my altitude of 4,000 ft. I thought airliners always flew "way up there." In later years I too learned that you flew a DC-3 just like any other ship.

Popular Altitudes

Between New York and Washington, for instance, 6,000 and 7,000 ft. were the most used altitudes. Only when it was decidedly advantageous (or required) did you go higher.

Then came the pressurized models—the Convairs and DC-6s. Ah, now we would really fly high. The Convairs, we heard, were designed to cruise at 17,000 ft., the "sixes" even higher. And I must say that at first we attempted to comply with the brochures.

But it really didn't make much sense—except, of course, on long flights, over difficult terrain or weather. On the East Coast routes we soon went right back to the old DC-3 grooves.

Lots of Company

As a matter of fact, a certain trip of mine today habitually arrives over the Westchester (Pa.) omnirange at almost the same time as another DC-6, a DC-7, two Connies and a Martin. All are generally well below 10,000 ft.

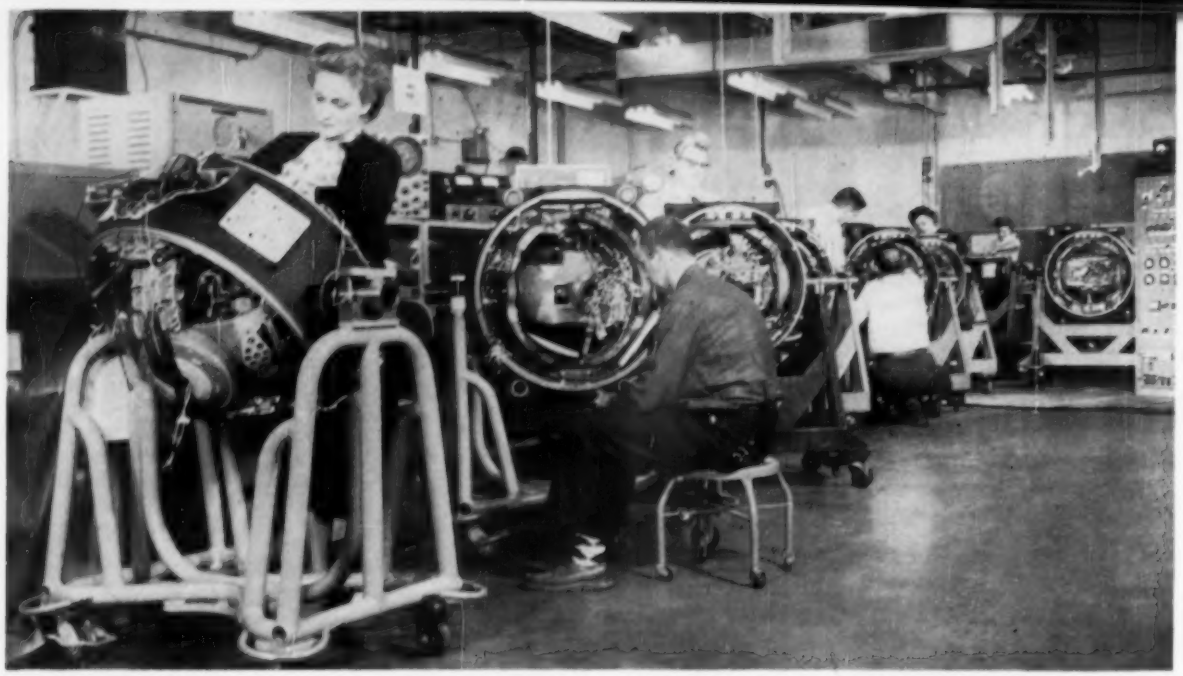
Within a few years the Lockheed Electras, the Boeing 707s, the DC-8s, Convair 880s and other turbine craft will make their appearance. Right now it is popular—because it seems more glamorous—to advertise the extremes at which these airplanes will fly. But just as there are innumerable "300 mph." ships running around the skies at an honest 250 mph., I'll bet many of these 30,000- and 40,000-ft. jobs will actually come closer to Earth.

This, of course, does not include coast-to-coast nonstops or other flights in which stage length demands maximum performance. Within or near the Golden Triangle (New York-Washington-Chicago) however, lies a large portion of our population.

Distances Won't Change

Distances between these large cities are not going to increase substantially in the next few years so it is difficult to see any great scarcity of traffic in the "low" altitudes even in the 1960s.

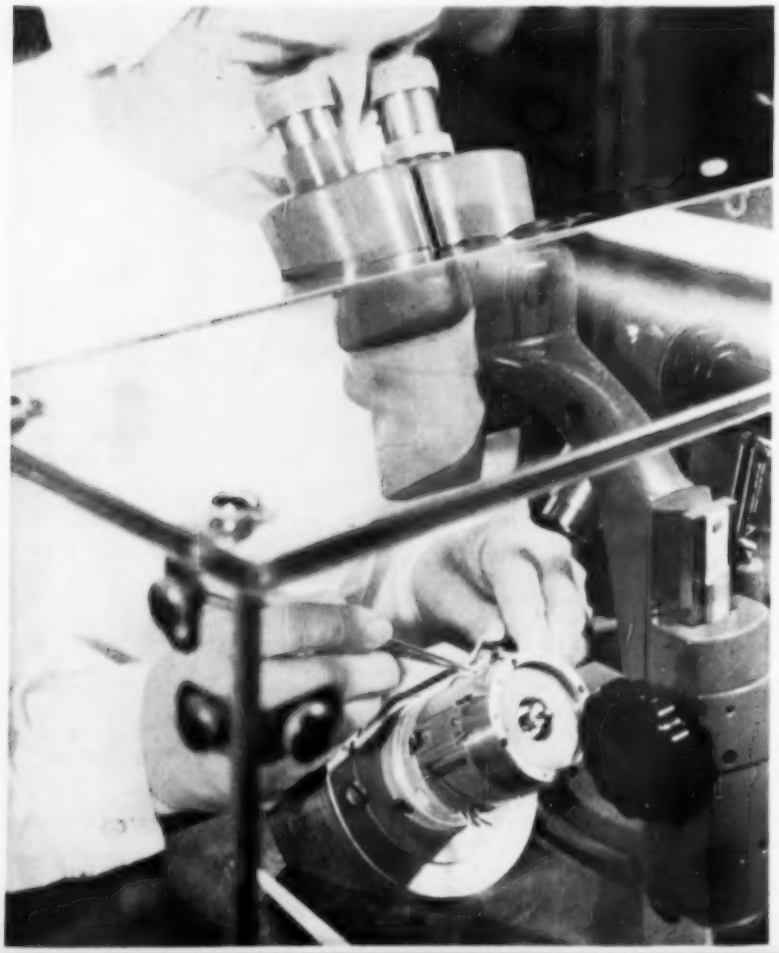
The point of all this harangue is that the coming of the "Jet Age" is not going to cause our low altitude problem to go away. If we have a serious job at the higher altitudes we have no less a task down below. In reality there is no line of demarcation which enables us to have two neat little piles, one labeled "high altitude" and one "low altitude." Whatever is done for high altitude jet traffic (and something must be done) must blend nicely with that down below. Those old DC-3 altitudes are still in for a lot more wear and tear.



FIRST PHOTOS of inertial guidance systems used in Thor intermediate range ballistic missile, show size and rugged construction of the three-gimbal stabilized platform. Thor guidance system is in quantity production at AC Spark Plug plants in Milwaukee.

Thor Guidance Goes on Production Line

HIGH-POWER microscopes are used to perform some of the critical gyro assembly operations and also to assure that every component part has been completely deburred.



By Philip J. Klass

Milwaukee—Thor intermediate range ballistic missile inertial guidance system, first to successfully fly an American IRBM, is now in quantity production here at AC Spark Plug, in the nation's largest inertial guidance manufacturing facility.

Excellent first-shot performance of the Thor guidance system has thrust AC Spark Plug into the forefront among inertial guidance manufacturers. The General Motors Division is producing similar inertial systems for the Navy's Regulus II and the Air Force's new TM-76 Matador.

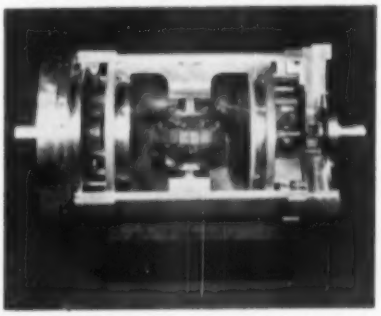
Size of Operation

The company has produced more inertial guidance systems for missile use than all other U. S. manufacturers combined, according to Bruce Schwarze, chief engineer of the military products division.

Success of Thor's guidance also is a coup for the Massachusetts Institute of Technology's Instrumentation Laboratory, headed by Drs. C. S. Draper and Walter Wrigley. The liquid-floated integrating gyro and simplified computational geometry employed in the Thor guidance were originally developed by M. I. T.

Performance of the AC inertial sys-

ELABORATE test equipment of extreme accuracy is required to check out three-gyro, three-accelerometer, three-gimbal stabilized platform used in Thor inertial guidance system.



INTEGRATING gyro, liquid-float type, shown in cutaway is heart of Thor guidance.

INTEGRATING accelerometer employs a pendulous liquid-floated integrating gyro.

tem in static, rocket sled and non-ballistic flight tests had prompted Air Force to drop the radio command guidance system being developed as a back-up by Bell Telephone Laboratories even prior to the first inertially guided Thor launching (AW Dec. 9, p. 23).

Tooled for Production

AC Spark Plug has tooled up extensively to permit inertial components and assemblies, some of which must be held to tolerances measured in millionths of an inch, to be fabricated and assembled almost entirely by women and girls without previous industrial experience. Approximately 70% of the personnel are women; men are used primarily as supervisors, and for setting up machine tools and heavy operations.

Inertial production currently is being transferred from AC's plants in Milwaukee to a new 215,000 sq. ft. facility in nearby Oak Creek which will be devoted exclusively to inertial system work.

Within several months a 125,000 sq. ft. addition to the Oak Creek plant will be completed and another 140,000 sq. ft. addition has been started, with completion scheduled for next fall, to give a total of 480,000 sq. ft.

Company currently has facilities to meet present Thor production schedules, but plans to increase current number of subcontractors and suppliers to permit rapid future production expansion if required, according to Vincent Ryb, manager of manufacturing.

If an IRBM's ballistic trajectory is to carry it to the target, the missile's position in inertial space and the direction/magnitude of its velocity vector at the instant of engine burn-out or cut-off must be accurately controlled. Providing the guidance intelligence for such control is the function of AC's inertial system.

Location of the target relative to the missile launch site roughly fixes the required IRBM position at burn-out, but its precise position at this instant also depends upon the direction/magnitude of the missile's velocity vector.

Guidance Problem

Thus to an IRBM inertial guidance system, the "target" is located out in inertial space but its exact position may shift as a result of unexpected variations in engine thrust or changes in missile attitude. This tends to complicate the task of guiding a ballistic missile.

Fortunately the problem is made somewhat easier because IRBM guidance is required for only a brief interval —something less than four minutes. This makes gyro drift and other cumulative types of guidance errors of less consequence than in inertial systems designed for piloted aircraft or non-ballistic missiles with relatively long times of flight.

AC's inertial system for the Thor employs three liquid-floated integrating gyros with angular momentums of 10^7 gm-cm.^{2}/sec. mounted on a three-gimbal stabilized platform. Gyro spin axes remain fixed in inertial space and are not Schuler tuned as in inertial systems designed for long times of flight.

Three pendulous integrating gyros perform the function of integrating accelerometers, providing output signals proportional to missile velocity along each of its three major axes. These velocity signals are integrated in an analog computer to compute missile displacement and deviation from a normal or idealized powered trajectory to provide corrective signals for the missile autopilot.

Thor's guidance employs a computational geometry, developed by M.I.T.'s Dr. Harold Lanning, which greatly reduces the complexity of the associated computer circuitry. Present Thor guidance uses vacuum tubes and magnetic amplifiers rather than transistors because of the desire to use proven components at the time the development was started.

However, AC has developed a completely transistorized inertial system for the Regulus II, and transistors may be employed in any subsequent Thor

PUMP PRIMERS

by
Arthur A. Nichols

Multiple functions and separate fluid systems can be combined and serviced with maximum efficiency by a single Gerotor pump.

Engine designers have recently been strongly attracted by Gerotor pumps which permit the incorporation of an extra pumping element in a separate chamber of the lubricating pump to provide fluid pressure for a control function or other use.

The unique construction of the Gerotor type pump permits aircraft systems designers to combine *several pumping functions* in a single pump housing mounted on a single pad and driven by a single shaft. Diversified systems such as lubrication, scavenging, low pressure hydraulic servo systems and motors up to pressures of about 1000 psi may be centralized in this manner. *(See fig. 1).*

Fig. 1. Multiple function pump.

The Gerotor pump is relatively simple. The moving elements are the toothed "Gerotors" — inner and outer. Both turn in the same direction and either one may be driven. The inner element always has one less tooth than the outer and the "missing tooth" provides a chamber to move the fluid from inlet to the discharge.

Both Gerotor parts are mounted eccentric to each other encircling the shaft. This permits stacking a number of sets of Gerotors along the same shaft, in a common housing. By providing each set with a separate compartment and inlet and discharge ports, several fluid systems can be served simultaneously and without interference *(See Fig. 2)*. Different capacities can be provided for each system by varying the diameter or thickness of the Gerotor elements to vary the volume of the tooth chamber.

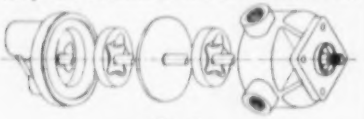


Fig. 2

Advantages — The Gerotor is a positive displacement pump. It is simple and compact, lightweight, valveless, provides high volumetric and mechanical efficiency.

Technical information plus complete custom engineering and precision manufacturing facilities are available to help you obtain the *right* pump to meet your specifications. Your inquiry is invited.

W. H. NICHOLS CO.
48 Woerd Ave., Waltham 54, Mass.

product improvement program.

Extremely husky construction is employed throughout the Thor guidance system, both for the stabilized platform and for the associated servo amplifier and computer circuitry. Missile environment in which the system would have to operate was largely an unknown quantity at the time design was begun, so ultra-conservative design practices were employed throughout to provide desired reliability and ruggedness.

Weight Estimate

Company officials decline to give weight figures on the complete guidance system, but an estimate of 500-1,000 lb. appears reasonable. On the basis of present knowledge of actual Thor environment, company believes it can produce a smaller, lighter-weight, more accurate guidance system.

The multi-million dollar Oak Creek plant is owned by General Motors, but most of the machine tools and equipment are government-financed on a special tooling contract. Plant is laid out for in-line flow of materials and work-in-process, but there is no attempt at a conveyor-belt type assembly line.

Machining tolerances required for many of the inertial components are so tight that in many instances AC has been forced to rebuild new machine tools to obtain the required accuracies. Others have been built to its special requirements. Typical is a battery of Heald Bore-Matics used to bore holes in aluminum gimbals which make up the stabilized platform.

Precision automatic gaging equipment is built into some machines, like the Heald Bore-Matics, to continuously monitor performance. In other cases the gaging equipment is immediately adjoining the machine and the worker checks each piece upon its completion.

Smaller machine tools operated by women, are set up by men who run first piece through and check it before turning the machine over to the female operator. Male inspectors periodically check the output of each machine in addition to the customary inspection of all finished parts.

Tight Tolerances

Some idea of the precision required in component test and gaging equipment can be gained from the fact that taper of the gyro wheel must not exceed 0.000050 in. and that mass shift of the gyro wheel on its bearings must be held to the order of 0.000001 (one millionth) inch.

One small stainless steel spacer, hardened to 65 Rockwell C, must be ground to a thickness of about 0.161 in. to a tolerance of 0.000025 in., its surfaces must be parallel to within 0.000025 in. and its edges square to within 0.000030 in. Operation for this one simple component requires about 15 min.

Every single part of an inertial gyro has to be thoroughly deburred because a

How AC Entered Inertial Guidance

AC Spark Plug, which has long been a manufacturer of autopilots, bombing and fire control systems and similar precision military gear, first entered the inertial guidance field about eight years ago. As result of previous association with Massachusetts Institute of Technology's Instrumentation Laboratory on fire control equipment, company became interested in inertial guidance work of M.I.T.'s Dr. C. S. Draper and associates.

In 1951, under Air Force contract, AC began development of SIBS—a stellar-inertial bombing system. Celestial fixes were believed necessary because accuracy of existing gyros and accelerometers was not good enough for a pure inertial system of required accuracy. AC's current inertial guidance systems for the Thor, Matador TM-76 and Regulus II are a direct outgrowth of this early work.

Thank You ...

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for the biggest sales year in the history of

HYDRO-AIRE

particle only two microns in diameter can foul up gyro performance. AC employs liquid honing and sand blasting wherever possible but has a continuing program of development to find still better techniques.

Every part is examined under a 30-power microscope by female operators who work with a complete assortment of dental tools, rubber erasers, steel wool, cotton and sewing needles which are specially ground to tool shapes. It is not uncommon for a girl to spend several hours deburring a single gyro component.

Gyro Assembly

Gyro assembly rooms follow the familiar industry practices: air conditioned using heavily filtered air under pressure whose temperature is carefully controlled. Employes are clothed in nylon smocks and hats. Female employes are not allowed to wear face powder and all employes in gyro assembly use special hand lotion to close off skin pores.

Despite these careful controls, gyro assembly rooms are vacuumed and swabbed down twice a day. Tools employed in assembly are used only on a single gyro, then packed up and sent out for cleaning to prevent any contaminant from spoiling more than a single gyro. After cleaning, tools are sealed in air-tight bags and returned.

The inspection and test sheets for every single component that goes into an individual gyro are assembled into a complete log and filed away for future reference. These individual gyro logs sometimes provide invaluable clues when engineers are trying to sleuth the cause of subsequent inertial system failure from very meager telemetry data available at the time of failure.

Reliability Procedure

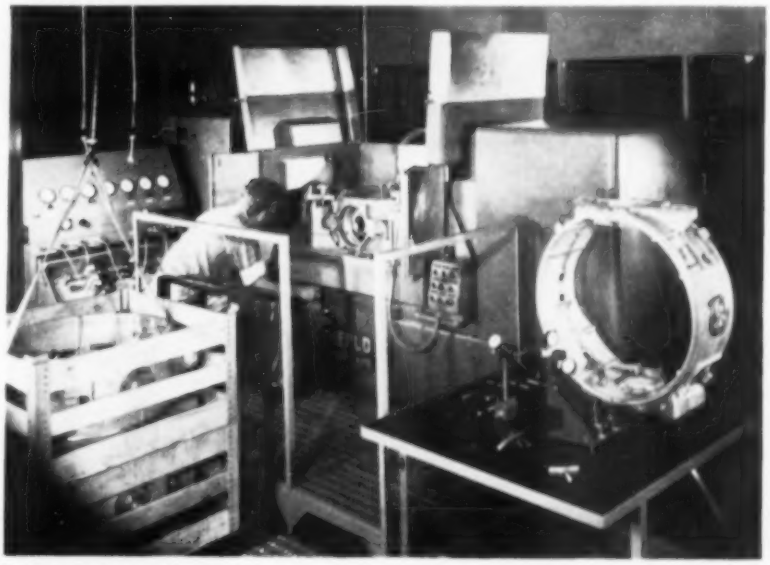
Every component failure or malfunction, regardless of whether it occurs in development models, in production or final test, or in the field, is reported back to AC's Reliability & Standards Department on a "Discrepancy Report." Report is filled out to show the particular operation during which failure occurred, equipment environment at the time, how many hours or cycles of operation preceded failure plus other information which will help reliability group and design engineer determine cause of failure.

Copies of the report are immediately distributed to interested personnel in engineering, inspection, manufacturing and/or purchasing. Report is also converted to IBM punch card format and all failures are automatically tabulated by machine according to type of part, its circuit position or use, or any other criteria which may point up a failure pattern, according to Donald Cummings, head of the reliability group.

When a pattern of failure becomes apparent, the reliability group sends a "Corrective Action Request" to the design engineer involved who must promptly recommend the required changes.

Failed components are returned to the reliability department for analysis by parts specialists. Later they are returned to the original vendor with a report on the cause of failure so he can take corrective action. Reliability group also performs initial component parts qualification tests and establishes approved list of suppliers. Engineers and

NEW AC Spark Plug plant at Oak Creek, near Milwaukee, is nation's largest inertial guidance manufacturing facility. Present 215,000 sq. ft. is being expanded to 480,000.



ULTRA-precision tolerances required in manufacture of many inertial components forced AC to rebuild many brand new machine tools to obtain required performance. Heald Bore-Matic above, one of several used in critical platform gimbal machining operations, has built in gaging system.

STERILE rooms used in assembly of gyros and accelerometers are air conditioned, pressurized with heavily filtered air, swabbed down twice a day to maintain required cleanliness.

New Missile, and

. . . driven by Sundstrand Controlled-Speed Hydraulic Motor

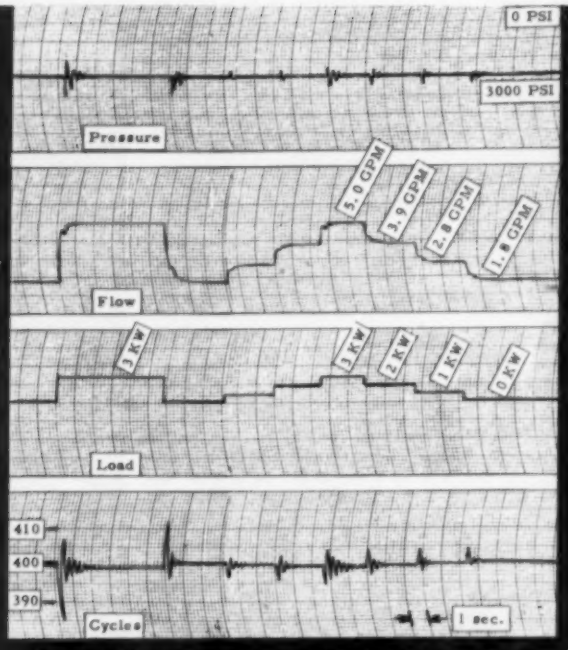
Compactness, light weight, and the ability to perform with high efficiency over a wide load range are outstanding characteristics of the new 400-cycle missile, emergency and isolated electrical power-generation system powered by Sundstrand's Controlled-Speed Hydraulic Motor.

High efficiency of the system is assured since the speed of the variable-displacement motor is controlled by varying the displacement to match the required torque output, and thus the motor takes only that flow of oil from the hydraulic system that is required to maintain the driven load. This eliminates the inefficient throttling necessary in a fixed-displacement motor system.

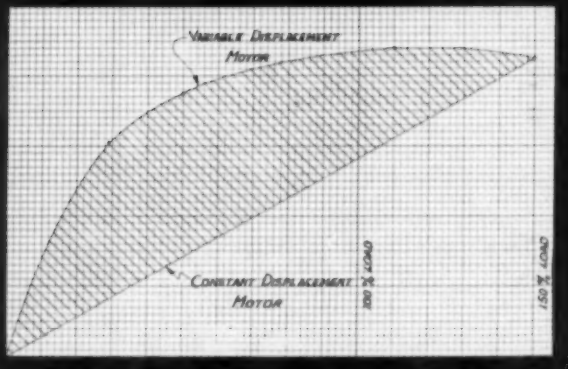
In the system shown, the controlled-speed motor is integrated in a common housing with the alternator. This offers the advantages of minimum weight and envelope, maximum vibration and shock resistance, and increased reliability. In addition, the integrated package permits a reliable method of cooling the alternator with oil when air cooling is impractical.

As shown, the system is rated at 4 kva with a 1.0 power factor and is capable of handling 100% overloads for extended periods. Operating temperature range of standard Sundstrand systems is from −65° F to 275° F. Higher temperature models are available as required.

The motor shown has a self-contained flyball governor, but it can be provided with external speed control wherever variable speed is required. The motor is particularly suited to driving any load where torque requirements are variable and heating of hydraulic fluid is critical.



Oscillograph trace of power-generating system performance with basic flyball governor. Governor trimming methods provide more precise control.

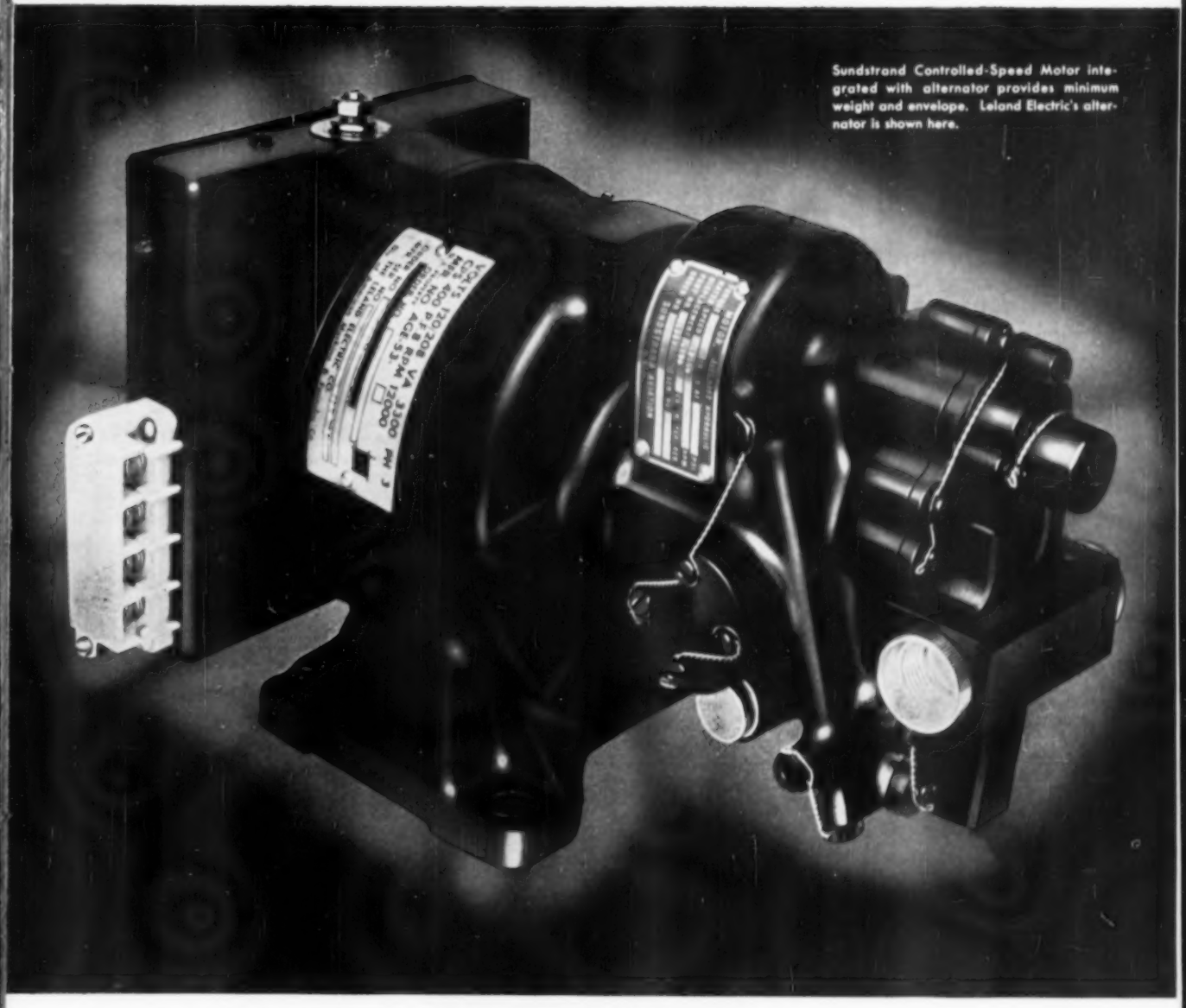


Efficiency advantage of variable-displacement motor over constant-speed motor is shown for loads ranging from 0 to 150% of rating.

These are outstanding characteristics of Sundstrand controlled-speed hydraulic motors:

- High efficiency throughout operating range.
- 4 kva rating with 100% overload permitted.
- Speed control with ±1/10% with trim, ±1½% with self-contained governor.
- No discontinuities in speed control from no load to maximum load.
- 1-second transient response.
- Operating temperatures ranging from −65° F to +275° F.
- Motors for operation at higher fluid temperatures available as required.

Emergency Isolated Power System



Sundstrand Controlled-Speed Motor integrated with alternator provides minimum weight and envelope. Leland Electric's alternator is shown here.

First in Constant Speed Drives

SUNDSTRAND AVIATION

Division of Sundstrand Machine Tool Company, Rockford, Illinois
Sundstrand-Denver: Denver, Colorado. Western District Office: Hawthorne, California

purchasing department are restricted to using and buying only qualified components, Cummings says.

AC's inertial guidance systems have been subjected to reliability-performance tests on rocket sleds at the Naval Ordnance Test Station in China Lake, Calif., to static firing tests at Edwards AFB and at Air Force Missile Test Center in Florida.

Concurrent with Thor guidance development, AC has been developing ground-based test equipment and training systems, according to William Stack, director of sales and contracts.

Although AC already has a large foot in the inertial guidance door, both Stack and Martin Caserio, manager of AC's Milwaukee operations, have their eyes on other missiles, including several for which other companies currently are developing inertial systems. AC believes it has demonstrated the ability to strip the "black magic" away from the manufacture of inertial guidance systems.

FILTER CENTER

► **Bromo Seltzer Cures Headache**—In the nose cone for the Atlas ICBM and Thor IRBM, data capsule containing telemetry data recorded as backup for transmitted information is ejected just before missile impact. Problem of delaying electronic marker beacon transmissions for about three minutes—until capsule had shed its protective covering

as it floated in the ocean—defeated mechanical switches. Problem was solved with a concentric-cylinder sea water switch in the battery lead packed with Bromo Seltzer which delays entrance of the water until it has dissolved. Nose cones are being developed by General Electric's Missile and Ordnance Systems Department.

► **Uncle Sam Best Customer**—Defense and other government procurement now represents about 50% of electronic manufacturers output, compared with only about 20% in 1950. In same period, home entertainment products (TV, radio) dropped from 58 to 21% of industry output, according to Electronic Industries Assn., making Uncle Sam the industry's biggest customer. Association estimates that 23% of military procurement dollar goes to electronic manufacturers.

► **Speedy Check-out**—A 15 lb. pre-flight tester, which enables pilot or maintenance personnel to quickly check out performance of an interceptor fire control system either in the air or on the ground, has been developed by Westinghouse Air Arm Division under Navy Bureau of Aeronautics sponsorship. Pre-flight checker also enables pilot to make "dry runs" for practice without radiating electromagnetic energy during periods of fleet blackout, Westinghouse says.

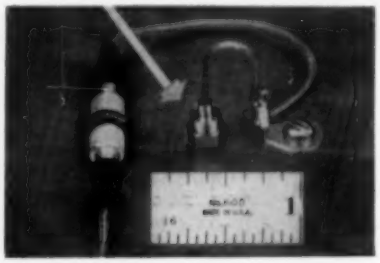
► **Rapid-Fire Computer**—Digital computer, called the "first which is fast enough to evaluate performance of a missile in full flight" was unveiled by Packard-Bell at recent Eastern Joint Computer Conference in Washington. The transistorized real-time incremental computer, called "Thrice" for short, can solve a complete set of equations in 10 microseconds, 24 times faster than conventional digital computers, according to Packard-Bell.

► **Sperry Semiconductors Available**—High reliability silicon semiconductors for critical applications are now commercially available from Sperry Semiconductor Division, established last year in Norwalk, Conn. Sperry says 17 types of silicon diodes are being produced under microscopes "by push button-controlled machines." Every unit reportedly is tested for 240 hr. at high temperatures to assure operating stability.

NEW AVIONIC PRODUCTS

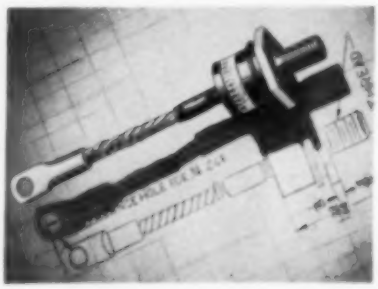
Components & Devices

• **Accelerometers,** Series 600, have been developed for shock and vibration measurements of small components and systems. Barium titanate in compression is used for the sensing element to attain a natural frequency of 150 kc. and



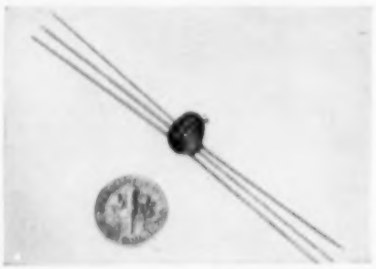
a sensitivity of 1 mv./g. Acceleration range is from 1G to 40,000G with frequency coverage from 5 cps. to 50 kc. Columbia Research Laboratories, Woodlyn, Pa.

• **Silicon power rectifier,** Type 1N412B, is designed to meet requirements of MIL-E-1 and MIL-T-19500-A. Rating of 35 amp. rectified d.c. output current with PIV rating of 100 v. has been approved under MIL-T-12679/26 (sig C).



Available, but not covered by individual military specifications, are the 1N411B and 1N413B rated at 35 amp. with PIV voltages of 50 and 200 v. respectively. International Rectifier Corp., El Segundo, Calif.

• **Pulse transformer,** Type ES-3, is designed for use in transistor blocking oscillator circuits. Encapsulated in epoxy resin, transformer has ½ in. maximum dimension. ES-3 is available with two or three windings, with coil



inductances to 3 mh. Leads are No. 14 AWG tinned copper. Power rating of these units is 1 w. average and 50 w. peak pulse power. Information is available from Pulse Engineering, 2657 Spring St., Redwood City, Calif.

• **Matched-pair power transistors,** Types 2N399 and 2N401, are designed for low-distortion audio and servo power amplifier applications. Units will dissipate up to 25 w. Typical Class B undistorted output power for both types is 8 w. The 2N399 is a high gain transistor and the 2N401 is a medium gain power output transistor. Red Bank Division, Bendix Aviation Corp., 201 Westwood Ave., Long Branch, N. J.

Studies Probe Man's Function in Space

By Richard Sweeney

Los Angeles—In an effort to thoroughly research man's problems of existence and function in flight beyond the atmosphere before manned space flight is attempted, human factors groups of Southern California contractors already have a variety of efforts under way.

While some work is under contract with a service, much of it is company sponsored. The range of research extends from proposals to a service for specific investigations to company-underwritten general thinking efforts. Environments and regimes extend from high troposphere and supersonics to exosphere and hypersonics.

These efforts are purely in human factors—have no connection with proposals being made by major firms for manned satellites and other advanced flights.

North American Proposal

North American Aviation's Los Angeles Division proposes an investigation in which the first step would be an accurate definition of a mission profile to seek the logical direction for subsequent work.

To be determined would be new pilot display requirements and navigational aids, the logical position and functions of a computer in the system and determination of whether a man is capable of varying power and velocity as desired throughout the operational envelope.

Other aspects are the environmental conditions, whether a complete artificial environment is required and, if so, what kind.

Realizing that presently envisioned accelerations and declerations for dispatch and recovery of a satellite, which are necessary to avoid loss of the vehicle due to burning up in atmosphere, are far beyond the capabilities of humans to withstand, investigation is proposed that would closely calculate new parameters under which man can function. These would be thoroughly dissected to see if man can possibly control or alter them to his own advantage while they are in process.

All data presently published and available would be gathered, assimilated and work would proceed from there. Substantial contributions here would come from work already accomplished toward successful flight of the X-15 research vehicle.

Following these studies, there would be better definition of those areas where more pure research is necessary. Hardware would be almost the least of the problems because of the currently available weaponry items that could be reworked as necessary.

Several projects are in force within the human factors section of the engineering department at Convair San Diego. Two of these are laboratory efforts under way for approximately one year.

Convair Projects

One is a study in detail of the human tolerance to complex and transverse accelerations such as are encountered in a re-entry.

Second is a study of human tolerances to combined environmental stresses in today's high performance aircraft covering all aspects, such as unusual flight positions, accelerations, time stresses, heat and cold, visual, sensory and movement restrictions.

A third effort well under way concerns development of criteria concerning selection and training of biosatellite crews.

Fourth project is an analytical study of calculations on a manned nuclear propelled space vehicle.

Fifth project concerns human factors considerations in design of minimum capability required for a manned orbital vehicle.

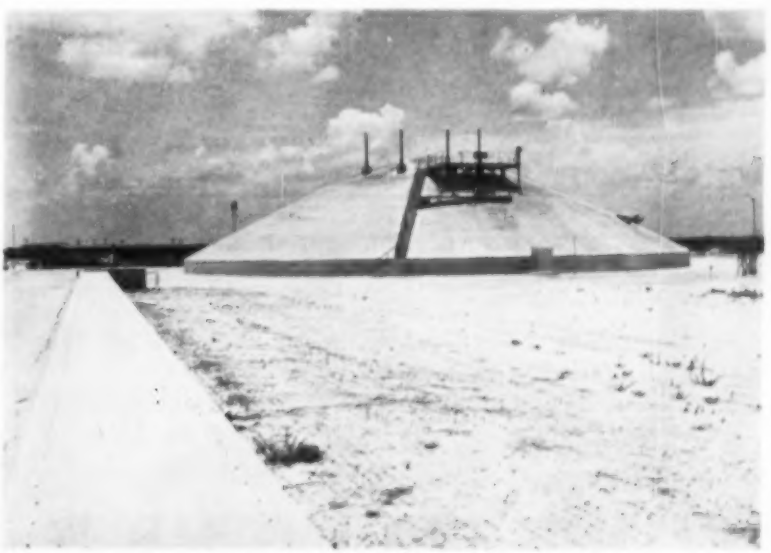
Douglas: Three Phases

At Douglas Aircraft's El Segundo Division, work has been categorized generally into three phases: First, in supersonics at altitudes up to 100,000 ft.; second, hypersonic—over Mach 5—flight at altitudes of up to one million ft.; the third, pure space flight.

Efforts in the first phase were carried out with the D-558-I research vehicle which reached Mach 2 at about 100,000 ft. Second regime has been proposed to the Office of Naval Research. Third would phase in at appropriate point.

In its research work, Douglas El Segundo has proceeded on two lines. One was investigations leading to solutions of immediate problems occurring on the rising curve of speeds and altitudes with each new airplane. The other line has been programming research so that, while proper areas of the future are receiving attention in basic research, the applied research which follows leads to producible hardware today.

In both lines, the division has worked to extend the knowledge from the platform of today's accomplish-



Sand Protects Atlas Blockhouse

Atlas intercontinental ballistic missile control blockhouse at Air Force Missile Test Center, Patrick AFB, has walls 6 to 10 ft. thick. Four periscopes protrude from reinforced concrete dome which is covered by 10-ft. layer of sand to absorb shock (AW Oct. 8, 1956, p. 62).

ments along the logical curve dictated by increases in speed and altitude.

In the early work following World War II, the division's efforts were directed at such problems as pilot comfort, pilot's control systems, pilot and equipment cooling. The problem of pilot displays led by the present Army-Navy Instrument Program (see p. 54).

Pilot Displays

Looking toward pilot displays of the future, Douglas people feel that the analogy philosophy of the present ANIP system will still be valid for flight at extreme altitudes and speeds. They feel that an analogy presentation that produces a mental image of what is happening to the craft that is compatible to the standard images a human pilot uses in everyday life—and in takeoff and landing of a very high speed and altitude craft—will most probably be best.

Research covers psychological and physiological aspects of extended regimes. Efforts have covered the reentry area, with its attendant stability and control of the vehicle itself and the thermal stress on pilots. Also considered is the problem of recovery of a very high and fast vehicle in case of a catastrophic emergency.

Another consideration is the results of acceleration-derived respiratory problems themselves as well as their effects on functional efficiency of pilots. Radiation also is under scrutiny.

Accelerations of both high and low frequency and magnitude are under study.

Navy Work

El Segundo Division contemplates additional work for the Office of Naval Research.

Douglas Long Beach human factors work has gone back to a basic premise—namely, what can a man in a space vehicle accomplish when considered in the light of the environment there, the provisions necessary for him to survive this environment; in short, why have him there in the first place?

The feeling is that a clear-cut definition of man's purpose is needed before

Research Leaders

Los Angeles—Human factors work at North American Aviation's Los Angeles Division is under the direction of Bruce Embody. Convair's efforts are being conducted under the leadership of Dr. Arnold M. Small. Douglas El Segundo projects are under the guidance of Al Mayo. Douglas Long Beach programs are headed by Dr. George Long.

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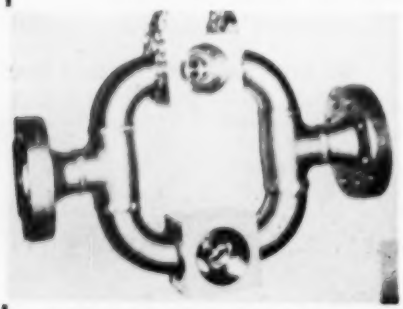

Typical Application

The 400-lb mild-steel welded assembly shown at left is used in mixing helium and nitrogen. It has been corrosion-proofed **inside and out** by Electroless Nickel plating.

Electroless Nickel plating was developed and patented by scientists of the U. S. Bureau of Standards. It will faithfully reproduce the profile to which it is applied—does not build up on projections, corners, etc. Electroless Nickel will produce a uniform coating on interior surfaces and other areas which would be inaccessible to conventional electroplating processes.

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calculated requirements for his survival and efficiency are nailed down.

Basically, it is known that the uncertainties and unknowns of space flight require man's unique abilities in order to overcome unexpected situations. When all possibilities of occurrences are known and understood, a black box will be able to accomplish the purposes of man much better. But until then, man will be required.

Going further back, the psychologist would like to know how a man makes a decision on anything, as well as on airplane situations. Certain facts are apparent on his aircraft instruments, yet his entire background and life experience are drawn upon in almost every decision he makes. This leads to the problem of how should training be accomplished for the first men going into space. There is no simulation for space flight, especially the aspects of weightlessness.

Weightlessness

Concerning weightlessness, it is not so much a worry as to whether a man can stand it physiologically, rather what will be its effect on his performance efficiency? How does one train a man to do the things which will be required of him under sub-gravity or zero gravity conditions?

Admittedly, just exactly what crew members will be required to do is not known, but postulating that certain activities will be required, how will men be trained in advance to work under these conditions, assuming that trained men in some quantity are needed? So far, it seems to be a foregone conclusion that training missions as they are understood today are out of the question.

In the past, certain experiments have been carried out using a partially filled water tank to achieve a semi-weightless impression, coupled with other possible environments of space. Disorientation to a major degree resulted after certain periods of time, not from weightlessness impression alone, but from the combinations of factors.

Researchers realize that real answers will not be obtained to this one small aspect of space flight in the first few hours of flight. Sustained periods will be required.

Man traveling under presently envisioned space velocity regimes will have to sleep this way. Can he? How much sleep will he need?

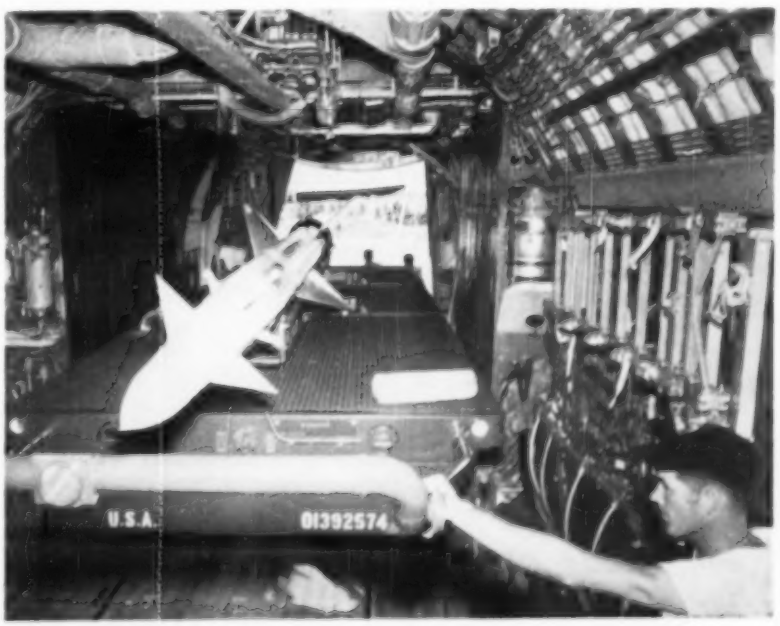
Zero Gravity Study

Will working under zero gravity reduce the muscular load to the extent that normal sleep quotas are not necessary? Will drugs play a part here?

Another area needing investigation is the question of using more than a minimum number of crew members. Studies are needed on inter-operator

C-130 Transports Missiles

Missile airlift is counted among capabilities of Lockheed C-130 Hercules turboprop transport. Four Nikes can be transported. Photo below illustrates how a single Nike is loaded aboard the Air Force aircraft. C-130 also is capable of airlifting Martin Matador (above). Transport shown is a C-130A. Lockheed recently was awarded a quantity production contract for C-130B covering 53 airplanes and valued at an estimated $100 million. Initial letter contract for the later version was for $22 million.



DESIGN PROBLEM: *A special switch*

PRACTICAL SOLUTION: *Call Cole*

In designing the new USAF T-38 Jet Trainer, Northrop Aircraft, Inc. was faced with the problem of developing a special switch to actuate the landing-gear indicator lights that would be absolutely reliable under extreme environmental conditions. The logical solution was to call in a firm with vast experience and outstanding success in this particular field . . . Cole Electric Co.

Not only did Cole develop a switch that surpasses all requirements, but is utilizing its competent production and testing facilities to assure dependable performance of each switch and to maintain a co-ordinated delivery schedule.

The next time you have a development or production problem, do what many major aircraft manufacturers do . . . call Cole. Engineering and sales representatives from coast to coast — or call direct.

Cole Electric Co. Hermetically-sealed Rotary Sequencing and Indicating Switch. Two pole, double throw. 4 circuit. 10 amps, 30 volts D.C. Serrated actuating tube permits tandem mounting.

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variables to ascertain whether having more than the necessary people aboard can be beneficial. Is there a task of some sort which can be devised for this not-really-necessary crew member that can be so arranged that the unnecessary party will not only contribute something by his efforts themselves, but in so doing, bolster the performance of the essential crewman? This would lead to making the extra party's overall value such as to make it worth while to have him there in the first place, in view of his cost in weight and complexity of the vehicle.

Data Not Applied

Psychologists have gained a great deal of knowledge on human behavior. This knowledge, however, has not been as well and widely compiled and translated into useful engineering data as could be done.

The need for a substantial bridge linking the two situations is great. Work is necessary to take points of knowledge gained by researchers in widely scattered and unrelated investigations, put them together on a common chart, graph or other useful presentation to obtain a better picture for engineers on human functional relationships.

This type effort would contribute substantially to keeping man in a position to be able to do what is required of him in space flight.

Job Description

One aspect of this is derivation of a complete pilot's or crew member's job description for the vehicle in question.

In the reference frame of the tremendous velocities involved and time-distance relationships, it becomes apparent that a job description which incorporates man's decision making (managerial) ability will have to be drafted, which enables him to make efficient use of this capability but sufficiently in advance of required action that he can operate in a time-stress-free environment.

Job descriptions are now being devised for some of today's weapon systems.

These are not so difficult, working from existing hardware with a known mission requirement.

But the basic question on upcoming systems at very high altitudes and velocities will be "is a man required or not?"

The former basis of "this weapon system should accomplish this or that, have so many crewmen, etc.," should go by the board for the most efficient overall end product.

The new philosophy indicated is "the mission is this or that, do we need a man or not?"

Improving Performance, Safety Of Man Is ARDC Group's Goal

Philadelphia—Protection of the human being, performance of the human link in a weapon system and system application to assure maximum coordination and flow of information between human factor agencies and systems engineers are the three dominating lines of effort being pursued by the Human Factors Directorate of Air Research Development Command, Brig. Gen. Don Flickinger recently told AVIATION WEEK. Gen Flickinger is Director of Human Factors at ARDC headquarters.

Elaborating on the triple goal of ARDC's Human Factors Directorate, Gen. Flickinger made these points:

• **Protection** means have to be developed to protect the human elements of a weapon system before they can perform their jobs satisfactorily. This protection may be against myriad hazards: weather, radiation, microwaves, chemicals, high G forces, tumbling or crashes. All actual and potential hazards must be assayed, pin-pointed and eliminated.

• **Performance.** To achieve optimum performance of the human element of a weapon system—and thus have the most efficient possible system—human factors technicians, working closely with system engineers, must define the capability of the man or men working with the machine. Also, the system must be human engineered to fit the men and inputs to the men must be kept from reaching peaks or loading them to the point where they break down at crucial moments, such as during a count-down.

• **System applications.** Gen. Flickinger has created in his own directorate at ARDC Headquarters a System Application Division to organize and monitor the system support activities of human factor agencies in the laboratory and in the field. It will coordinate human factors interest in this area and will attempt to produce maximum flow of information and guidance between human factors groups on the one side and system engineers on the other.

Keynote Address

In a recent speech here (AW Dec. 16, p. 61), Gen Flickinger made two major points—"We human factors folk have finally arrived. We're not talking just to ourselves anymore." Second point was, "I submit to you that there is no such thing as an unmanned (weapon) system."

He also noted several questions asked or implied by symposium notes and by the topics of the speakers. Among them were:

• **Can human** characteristics be specified in engineering terms for design applications?

• **Have human factors** engineering data and theory crystallized sufficiently to make teaching it to engineering students worthwhile despite the still generally vast ignorance about the human being?

• **Can the human** be manipulated as if he were a reliable component in a system, or must he be treated statistically as if he were a joker in the deck?

• **Is the language** used by human factors technicians adequate to describe human inputs, outputs and transfer functions, or is it a barrier to communication with design engineers?

As Gen. Flickinger pointed out, these are not trivial questions. The answers to them are basic to an evaluation of how far up the ladder the state of the art of human factors has reached and also to planning where the science wants to go.

Human Factors Is Here

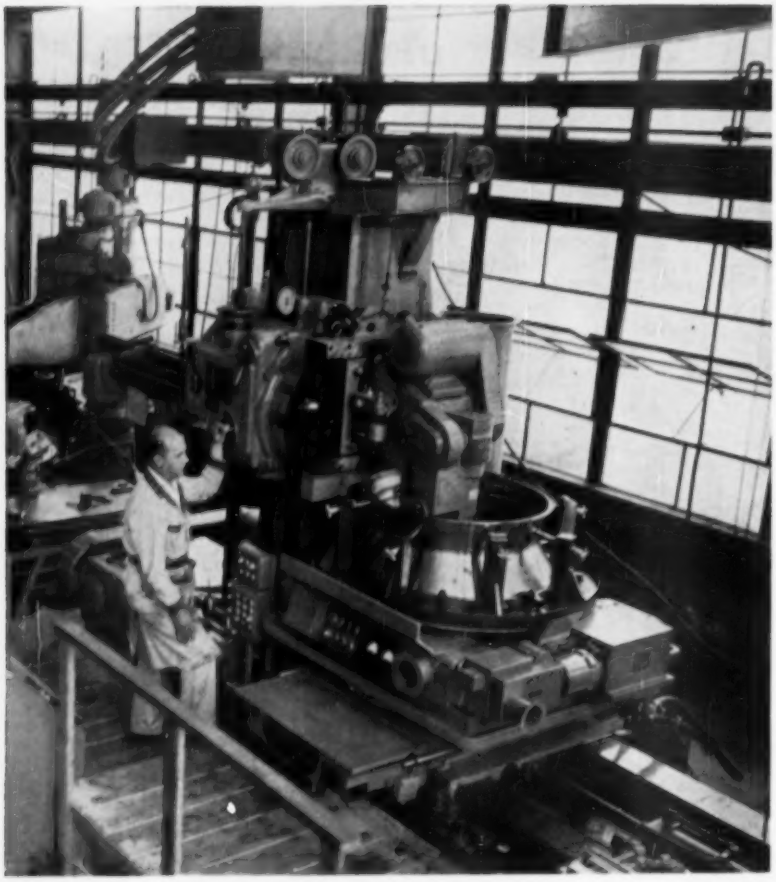
To reinforce his thesis that human factors has finally arrived, Gen. Flickinger stated: "I am convinced that, while we human factors types will not get very far alone, the growing willingness of engineers to take us into their systems planning activities is the most hopeful sign I have seen that these increasingly difficult problems will receive the necessary multi-sided consideration needed to break through to optimal solutions."

As far as unmanned systems are concerned, he said: "There is that intriguing concept summed up in the word 'system' which seems quite clear until it is modified by the adjectives 'manned' and 'unmanned.' There may indeed be unmanned systems if one is discussing ant beds, crystals, or galaxies, though the theologians among us would probably reject the notion that an intelligent plan did not enter into the organization of even those systems.

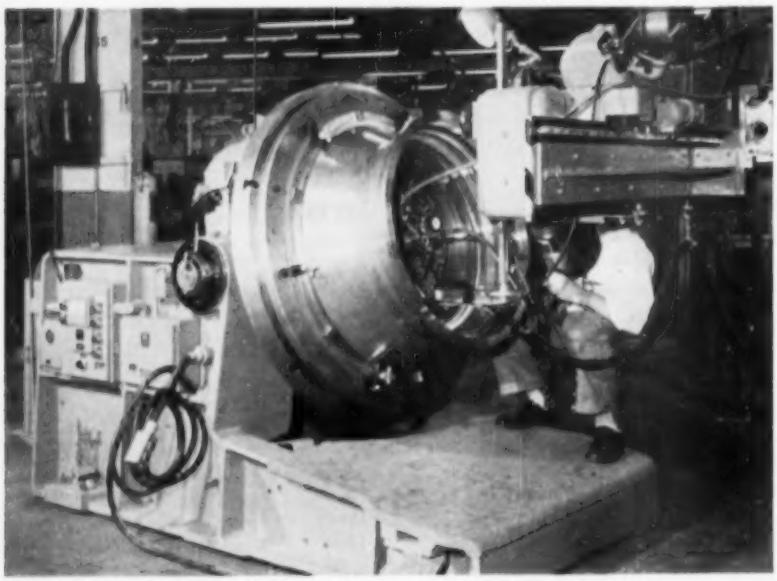
"However, where those systems which man himself plans, designs and constructs are concerned, I submit . . . that there is no such thing as an 'unmanned system.' It must be appreciated as axiomatic that all such systems have a man or men somewhere in the loop between planning, attempting, and replanning.

"Whether the question is one of fool-proof assembly, skillful maintenance, unerring operation, or parrying counteraction, man's performance in relation to the equipment which is involved will decisively affect the accomplishments of the 'system'."

Lycoming Tools



LYCOMING engineered this tape-controlled setup for milling turbine nozzle slots inside the casing. A tape-controlled Pratt & Whitney (Penn Texas Corp.) indexing machine was set on top of a Forges de Gilly horizontal boring mill, making the operation automatic.



INNER sheet metal ring is automatically welded inside J57 turbine casing. Operator monitors weld quality through Plexiglas cover which maintains inert argon weld atmosphere. Lycoming is now producing approximately 40 turbine cases per month and estimates that it is a major producer of the part.

Powerplant parts for Snark missiles and B-52 bombers foreshadow the degree to which subcontractors on missile programs will have to resort to expensive, special tooling setups, according to Lycoming Division, Avco Corp., Stratford, Conn., which is also making parts for Titan, Talos and Nike.

The precision production line used by Lycoming to be able to quantity-produce J57 turbine cases out of difficult-to-machine high temperature metals represents a considerable pre-production investment. Lycoming justifies the cost of having its tool and process engineer group create original machine combinations as necessary to gain realistic schedule and quality control over the finished product.

Machining Operations

Particularly, Lycoming points out that by combining as many of the machining operations into single setups and by automatizing as many of these as possible, it has substantially reduced the chance that a workman will scrap a part along the way by "pulling the wrong lever." The result has been to keep the plant scrap rate low and the rejection rate to the customer, the Ford Motor Co., Chicago, under 2%.

Starting with an A-286 high nickel steel rough forging from Taylor Forge & Pipe, Chicago, Ill., Lycoming used about a dozen steps, most of which have demanded original machinery redesigns.

Examples of the special Lycoming internally designed machine setups are:

- **Five internal** boring operations were combined on one 42 in. vertical lathe by ganging 24 tools on one rotating "christmas tree" holder. The setup performed 35 finish dimensions in one operation, 29 finish dimensions in the other, all accurate to ±.001 in.
- **Tape controlled** integration of built-up tool combinations for milling turbine nozzle blade slots inside the casing. Lycoming tooling engineers fixed a Pratt & Whitney (Penn Texas Corp.) indexing machine on top of a Forges de Gilly horizontal boring mill, and added hydraulic feed. Electronic tape control sequenced the assortment from slot to slot, making the operation automatic.
- **Reduction** of the tedious drilling of the 509 holes in the casing for bolt rings and lubrication to a number of automatic drilling fixtures. Most impressive of these was the overhead drill spindle arrangement nicknamed Nike by Lycoming workmen. At an angle determined by the overhead guide rails, the Nike drilled 44 holes $\frac{5}{16}$ in. in diameter, $\frac{3}{4}$ in. deep.

Lycoming is now producing 40 turbine cases per month and estimates

for Snark's J57

that it is one of the major producers of this part although Firestone Steel Products, Akron, Ohio, and prime contractor Ford also produce the casing. Most of the casings for the commercial J57s are produced by the engine's designer, Pratt & Whitney Division, United Aircraft Corp., at Hartford, Conn., but Lycoming, which has the tooling capacity to double its present production rate, is interested in possible commercial version subcontracts.

Lycoming's Diversity

Concerning his company's subcontracting status, a spokesman for Lycoming told AVIATION WEEK that the diversity of Lycoming's subcontracting has kept it from feeling the full impact of present cutbacks. However, he indicated that for the future Lycoming is making a strong bid to extend the work it is doing on the Nike, Talos and Titan missiles to other promising missile programs.

To this end Lycoming has been adding equipment slanted toward the needs of missile subcontracting. For example it now has hydraform machines capable of handling 31 in. blanks. Hydraform machines would be used to form missile items such as the dished ends of propellant tanks, portions of skins, or preforming spinning blanks for nose cones and rocket nozzles.

As future missile, high performance aircraft and VTOL designs demand lower fractions of structure and engine weight for total takeoff weight, it has been predicted that manufacture will continue to grow more complex.

Future Business

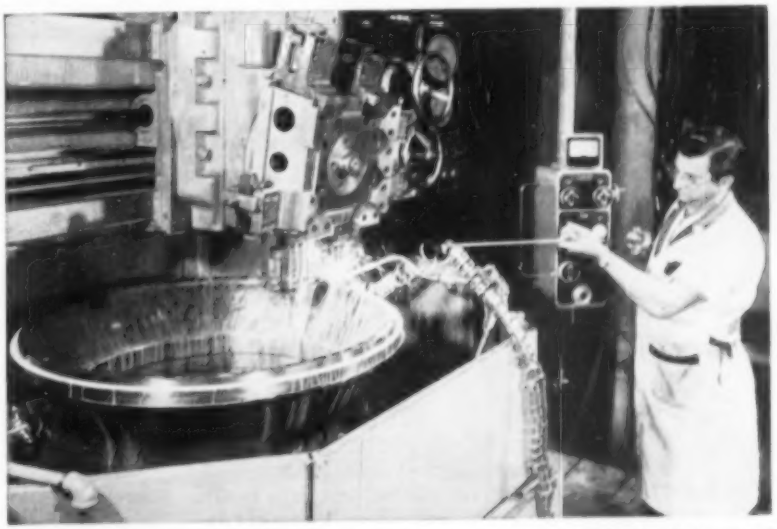
In turn the future for many subcontractors will hinge more and more upon the degree to which they have developed special talents in the particularly difficult areas, according to observers at Lycoming and other subcontracting firms.

Pre-production tooling will tend to require more and more original creative engineering effort and will of necessity become an important factor in figuring job cost and lead time.

This may require more advanced manufacturing study contracts such as one subcontractor, Aeronca Manufacturing Corp., Middletown, Ohio, has received from Convair for the Atlas ICBM.

Still another example is Liberty Aircraft Products, Farmingdale, L. I., which has been using its mammoth skin milling machines to reduce slabs from 1,850 lb. to less than 200 lb. to form contoured single piece tops and bottoms of the Grumman F-11F's wet (integral fuel tank) wing.

OVERHUNG drill spindle drills and reams blind holes from inside out. The indexing table floats on a cushion of air while turning. Pre-production tooling will tend to require more original creative engineering effort and will be important in cost, time estimates.



LARGE chips curl off as rough forging is hogged down on Bullard Man-Au-Trol vertical lathe. The forging is reduced from 850 to 90 lb. as it passes this operation. Lycoming is making a strong bid to extend the work it is doing on Nike, Talos and Titan.

AFTER 1000 FLYING HOURS—The lead aircraft in this formation of five Army H-37As (Sikorsky S-56s) over Fort Rucker, Ala., completed 1000 hours of accelerated test flying within six months after delivery, a unique record for helicopters.

A new Army command, the Transportation Aircraft Test and Support Activity, conducted the unprecedented testing program. The big H-37A was the command's first assignment in a program designed to develop a system to provide engineering data.

AROUND THE WORLD WITH SIKORSKY HELICOPTERS

OVER ANTARCTIC ICE—A Navy HO4S (Sikorsky S-55) hovers over the Coast Guard icebreaker *Northwind* in the Antarctic, supporting U. S. participation in the activities of the International Geophysical Year. Sikorsky helicopters are vital to the exploration and development of hard-to-reach areas the world over.

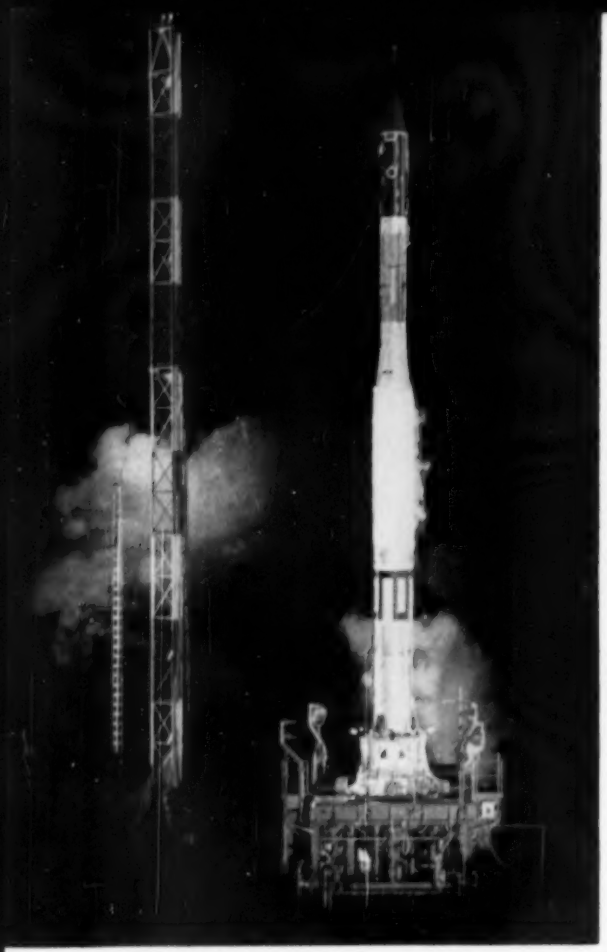
OVER THE BEACHHEAD—A Marine Corps HUS (Sikorsky S-58) takes off from the carrier Leyte during exercises in the Caribbean. The HUS normally carries up to 12 passengers, or even more for short distances. Current Marine Corps tactics emphasize vertical envelopment of enemy areas using many transport helicopters.

JUNGLE OIL AIRLIFT—Sikorsky S-58 helicopters in New Guinea have pioneered a far-reaching new technique in oil drilling operations. With loads averaging about 4000 pounds, they recently flew all personnel, construction equipment, drilling rigs, and supplies to several jungle drilling sites. Costly, time-consuming road construction was not necessary, and only a few months were needed to do the entire rig emplacement job by S-58. It is estimated 18 months would have been required if ordinary ground transportation had been used. Above, an S-58 lands supplies at a drill rig which itself was flown to the site in sections by S-58.

SIKORSKY AIRCRAFT

STRATFORD, CONNECTICUT

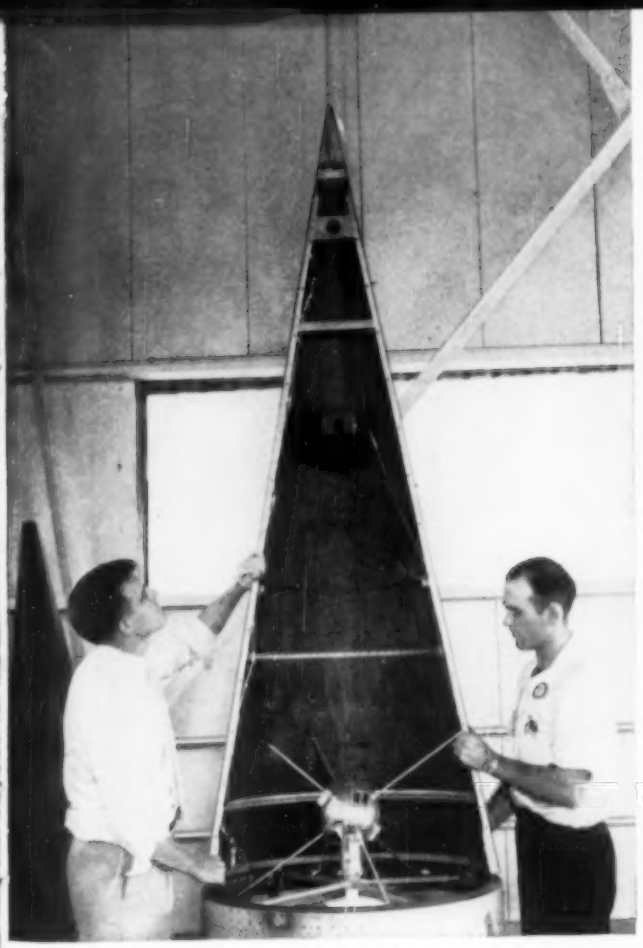
One of the Divisions of United Aircraft Corporation

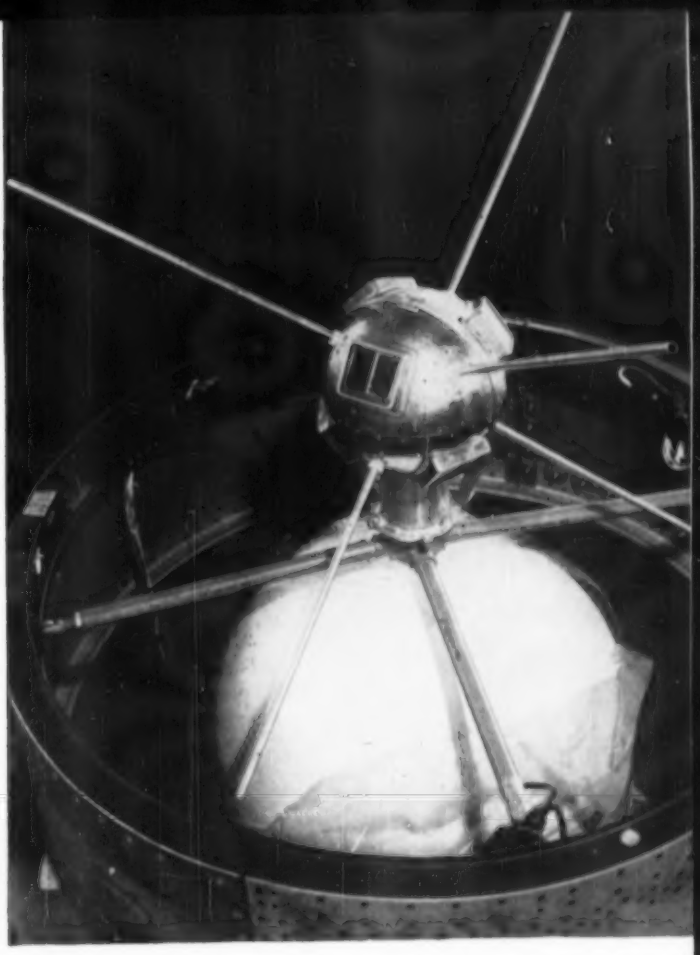


PRELIMINARY testing involves static firing, as illustrated by photograph of the Test Vehicle 3 first-stage engine undergoing static test at night on Cape Canaveral. Naval Research Laboratory machinist (right) inserts instrumentation package in 6.4 in. dia., 3¼ lb. test sphere. Baby satellite contains two miniature radio transmitters, one powered by mercury batteries, the other by solar batteries.

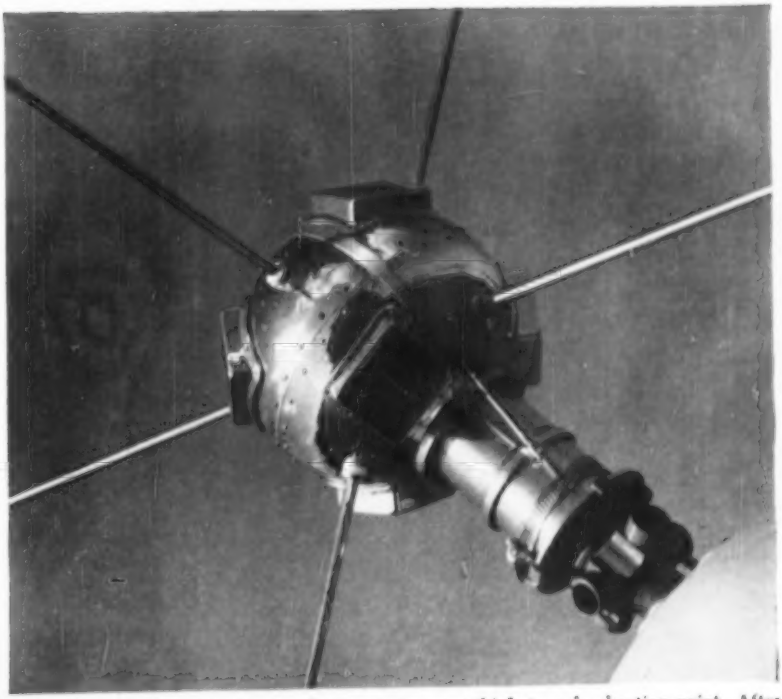
Vanguard Program Moves Toward TV-4 Launching

BRITISH newspaper headlines (below, left) reported results of aborted Dec. 6 launching of Vanguard Test Vehicle 3. Press photographers (below, right) set up cameras on Air Force trailer to record Vanguard launching. Vanguard Test Vehicle 4 may be launched in January.

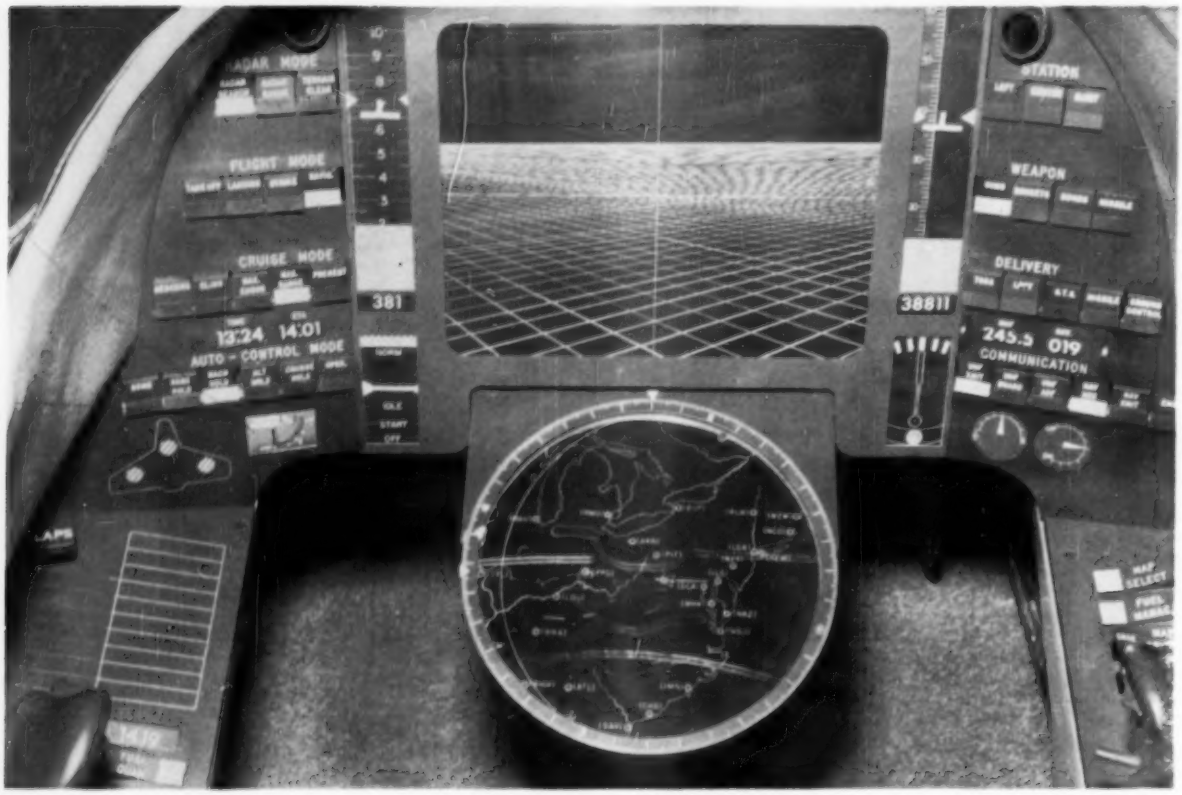




BALL on end of nose probe (above) protects arrow-shaped angle of attack indicator. Transmitter just inside nose cone relays angle of attack data to ground—not to guidance system. Data is plotted on graphs for benefit of ground crew. Metal strap (top right photo) protects satellite from jarring or displacement during preliminary steps, is removed before nose cone is put on.



TIMER in separation unit is designed to start at proper third stage deceleration point. After 26 sec., motor circuits close to pull hold-down pins, rotate spring release, eject sphere.



VERTICAL situation cathode ray tube in Douglas Aircraft's proposed cockpit display for A4D is 7½ in. high, 10 in. wide. It would show moving diagonal lines with proper convergence to give analogy of passing over Earth. Horizontal situation display is ringed by compass.

Douglas Proposes TV Cockpit for A4D

By Richard Sweeney

El Segundo, Calif.—Douglas Aircraft's El Segundo Division is proposing an operational cockpit for its A4D attack plane built around cathode ray tube presentation of contact analog information.

Scheduled for introduction in 1960-61, if proposal is accepted by Navy, new cockpit presentation would use conventional shaped cathode ray tubes for vertical situation (attitude) and horizontal situation (navigation and related functions) displays.

Although designed around cathode ray tube presentations, proposed cockpit does not conform to presently envisioned Army-Navy Instrument Program goal of flat transparent cathode ray tubes and ultra simplification of cockpits.

Transition Move

Rather, it represents a large step away from today's operational presentations toward Army-Navy Instrument Program cockpit.

While this is the first proposal for an operational cockpit along the Army-Navy philosophy, the first flying cathode ray tube hardware was announced earlier this year in a T2V-1 test bed, now being test flown at Douglas (AW Oct. 21, p. 21).

Features of the proposed cockpit, which provides for all weather, all modes operations, are:

- **Vertical cathode** ray tube situation display mounted in the center of what is today's instrument panel.
- **Horizontal situation** display tube mounted just below vertical display, but angled slightly toward pilot.
- **Flight control stick** mounted on console on right hand side of cockpit, operated primarily by hand movements rather than arm as in conventional sticks.

One major variation from the ultimate Army-Navy Instrument Program display is the use, on each side of the vertical situation display, of fixed vertical scales for Mach number and altitude, with moving bars indicating aircraft's current status.

Basic system consists of various sensors such as radar, static-pitot, liquid level and flow, air pressure and temperature, feeding information into a computer, which sends computed data to electronic display generator which translates it into form suitable for use on the proper readout.

Airborne Computer

System would use lightweight airborne digital computer, pre-programmed to accommodate the various combinations of operational modes possible for the aircraft. Present thinking is that the computer could be originally programmed for all usual operations, require reprogramming only in case of major change in aircraft or its military stores.

A highlight of the system is the cathode ray tube which, while conventional in shape, would incorporate transparent phosphorus developed by Paul Egli at Naval Research Laboratory, Anacostia, which are not excited by ambient light. Tube would have circular polarizing filter and black absorbent

coating inside, the combination eliminating reflected light, enabling pilot to see clearly desired information on either tube regardless of outside light conditions.

Design philosophy of this cockpit calls for vertical panel presentations indicative of, in addition to present status, what pilot will probably do in the next two seconds to five minutes, while the horizontal arrangement is for long range planning.

Cockpit Layout

Cockpit layout is such that all primary controls and information readouts lie within the pilot's 30 deg. angle of vision, can be seen without turning the head.

Lone exception is cabin environment control, located on right console underneath pilot's arm operating flight control stick.

The vertical situation cathode ray tube is 7½ in. high, 10 in. wide. As presently designed, it would show moving diagonal lines with proper convergence to give analogy of passing over Earth. A horizon lubber line may be incorporated. Sky analogy will have a texture which has not yet been made final. Climb, dive and turn analogy would be expressed by movement of lines and texture to give a mental image the same as a pilot would have if flying contact. Information for normal flight and attack modes would both be radar derived.

Horizontal situation display has an 8-in. dia. case, with the display itself being 7 in. across. A graduated ring surrounds it with major compass points clearly marked.

Above the vertical situation display are two round indicators. On the left is the accelerometer with numerical values clearly marked. On the right is an oxygen quantity indicator, marked to "¼," "½," "¾" and "full." "Empty" indication would be one color. Another highly visible color moving up and down would indicate quantity remaining.

Mach Indicator

On the left of the vertical display is the Mach indicator, with graduations in tenths. A red and white crosshatched, vertically moving area at top shows buffet limit for the aircraft as a computed function of the aircraft's present condition with all applicable factors included in computation. Bottom of scale also has crosshatched area moving up and down, indicating the stall limit, again a computed function of existing mode, flight conditions. On each side of the scale are small triangular-shaped command indices, showing what Mach should be as a function of existing flight mode, again a computed function with all factors taken into account.

Moving up and down in the center of the scale, which is approximately 2 in. wide and about 9 in. long, is the moving bar which presents a computed Mach number for the airplane at the moment.

Lined-up bar and command indices indicate optimum condition.

At the very bottom of the scale is a numerical readout of computed true air speed in knots.

Standby System

Should computer fail, system has its own standby static-pitot system which feeds signal directly into the numerical part of the instrument, yields a readout of indicated airspeed in knots. A clutch is provided so that moving bar on the Mach scale also reverts to indicated values.

On the altitude vertical scale, similar conditions prevail. Graduations are spaced over the airplane's operational envelope. Moving crosshatched area at top and bottom of scale indicates upper altitude limit according to cabin pressure regulator, while bottom section yields either a value of terrain variation according to radio altitude of a preselected minimum safe altitude.

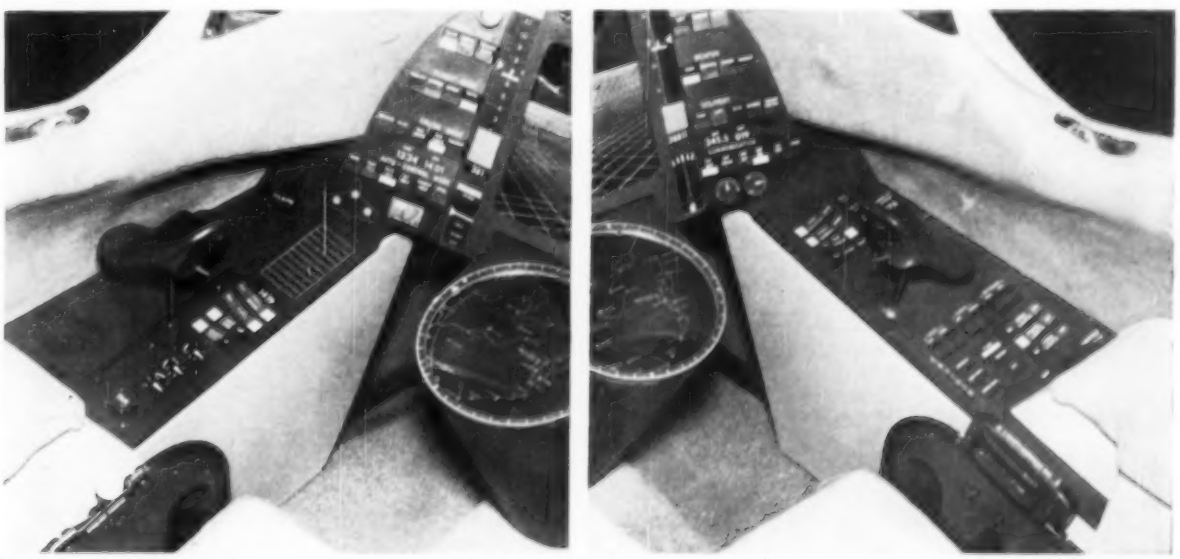
Command indices again are computed functions, as is the moving bar, which gives the aircraft's corrected altitude, or true pressure altitude. Numerical value windows again are incorporated at very bottom of the display, with the numbers indicating the airplane's present altitude in fine values.

Standby pressure sources again are furnished the numerical section, so that in case of computer failure, reading would be same as that of today's altimeter.

A clutching arrangement again provides for moving bar to revert to indicated altitude in case of computer malfunction.

Powerplant Data

On left of vertical situation display, under Mach scale, is the engine gage, yielding computed powerplant information. Markings are, from bottom upward, "off," "start," "idle," then the "normal" area. Throttle setting specifies what the powerplant should be doing, and command indices are positioned through computer. Engine's actual output is indicated by the moving bar, and alignment of bar indices shows powerplant is performing as it



FLIGHT control stick mounted on console on right hand side of cockpit is operated by hand movements rather than arm movements as in conventional sticks. Throttle control is mounted on left console. Consoles serve as armrests. Control handles are experimental.

should be for the specified flight mode, throttle setting.

Crosshatched section on engine gage is at top. Movement of engine condition indicator bar toward this zone without throttle movement of flight mode change indicates an engine malfunction other than loss of thrust, shown at bar dropping toward engine off position.

Across from engine gage, under altitude scale, is standby needle and ball.

To the left of the Mach scale are several rows of selector buttons for the various flight modes. Actuation of a button automatically brings in the proper computer program to yield accurate readouts on cathode ray tubes and scales for that mode specified.

Time Windows

Located on this panel will be three time windows, with the center giving the present time in 24 hr. clock numbers, the right one giving estimated time of arrival according to flight mode in effect. Left readout has not yet been made final, although pilot opinion seems to indicate preference for showing remaining flight endurance in present flight mode.

Below this, just above where the vertical panel becomes the left hand horizontal console, are standard landing gear and flap position indicators. A flap-actuating handle also is located near these indicators.

Landing gear and carrier tailhook operation as yet do not have separate switches, current thinking being in terms of their automatic extension at the proper time after the landing button is pushed on flight mode selector panel.

However, it has not yet been completely jelled as to whether separate switches will be provided in addition to landing button automatic operation, or whether gear and tailhook operating switches will be manually actuated outside the landing mode button, or exactly what provisions will be made.

Weapon Buttons

On vertical panel to the right of altitude scale are weapon mode selector buttons, plus communications buttons and indicators. Two round trim position indicators are below bottom communications button selector row.

The horizontal cathode ray tube display makes use of the fixed map and moving airplane principle. Variety of map selections will be available to pilot, with the largest covering the airplane's operational range.

Other scale maps for target areas, home base on expanded scale, are selected by pilot at will.

Display also will show a fuel range perimeter circle as a computed function of selected flight mode, or it can become a radius of action circle, both with provisions for reserve fuel for landing.

Movement of the aircraft symbol over the map indicates true ground track, although heading also is expressed.

Moving ring around map will be mechanically operated integrally with the selection of any certain map, indicate that map's orientation. Indices on outside and inside of ring can move to express track and heading respectively on the numerical graduations. These indices also may be hooked into radio

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Marines Demonstrate Helicopter Disembarkation

Marine infantrymen demonstrate method of disembarking from Sikrosky HUS-1 by sliding down knotted ropes while helicopter hovers. Technique permits the riflemen to leave vehicle safely from relatively high jumping-off point while keeping helicopter clear of terrain.

beacons, other navigation aids.

Should horizontal display tube malfunction, the moving ring will become a standby unit, orienting like a dual needle RMI.

Cockpit design calls for horizontal shelves, called consoles, along each side of cockpit.

Height is such that back by pilot's seat, consoles serve as armrests to relieve fatigue.

Mounted on left console is the throttle, having identical travel to today's A4D throttle.

A feature of both throttle and flight control are the handles, which are of experimental shape, and will service additional purposes with buttons incorporated on them, such as fixing a certain base or target on the horizontal situation display. Handles still are undergoing evaluation for shapes and location of buttons.

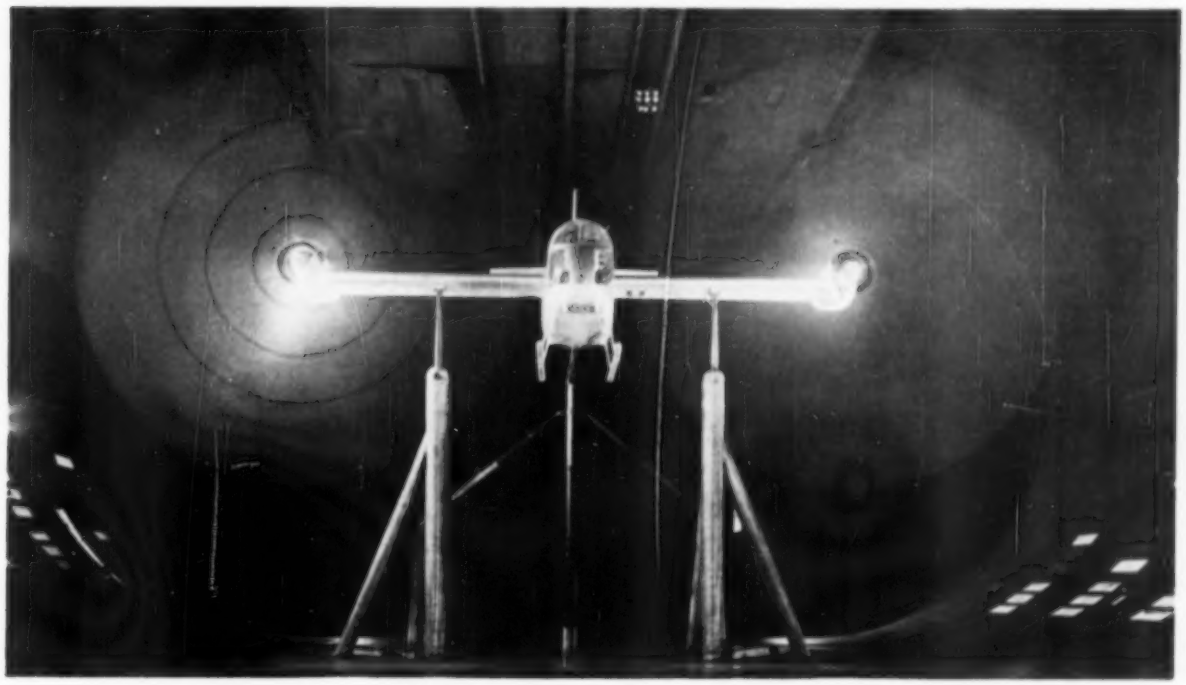
Standby Gages

On left console, where throttle travel slot is outboard of center, three standby engine gages are provided, giving turbine outlet temperature rpm. and oil pressure.

These small standby gages are just in front of left armrest. Ahead of this are internal fuel management controls and standby fuel quantity window which shows pounds remaining numerically. In front of this are various annunciator lights which essentially give a present status report.

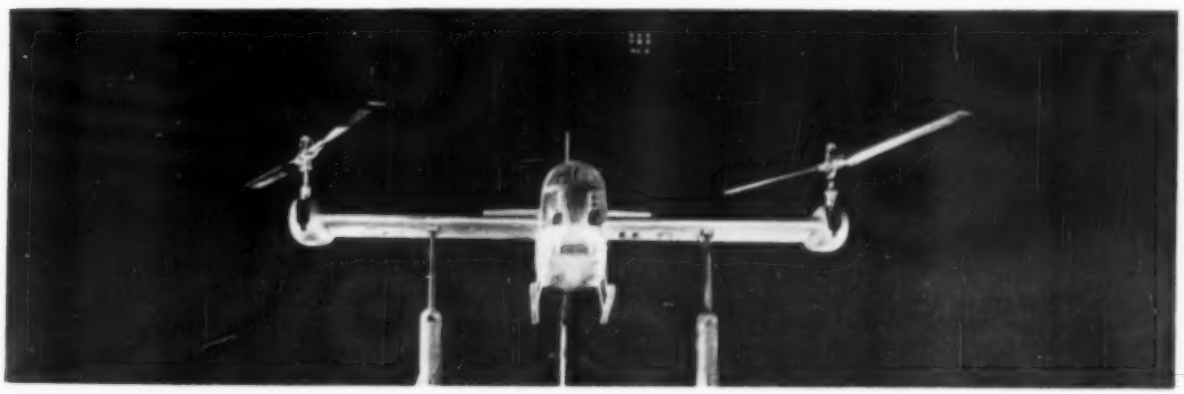
Lights indicating real emergency are located above vertical situation display, next to accelerometer reading and oxygen gages.

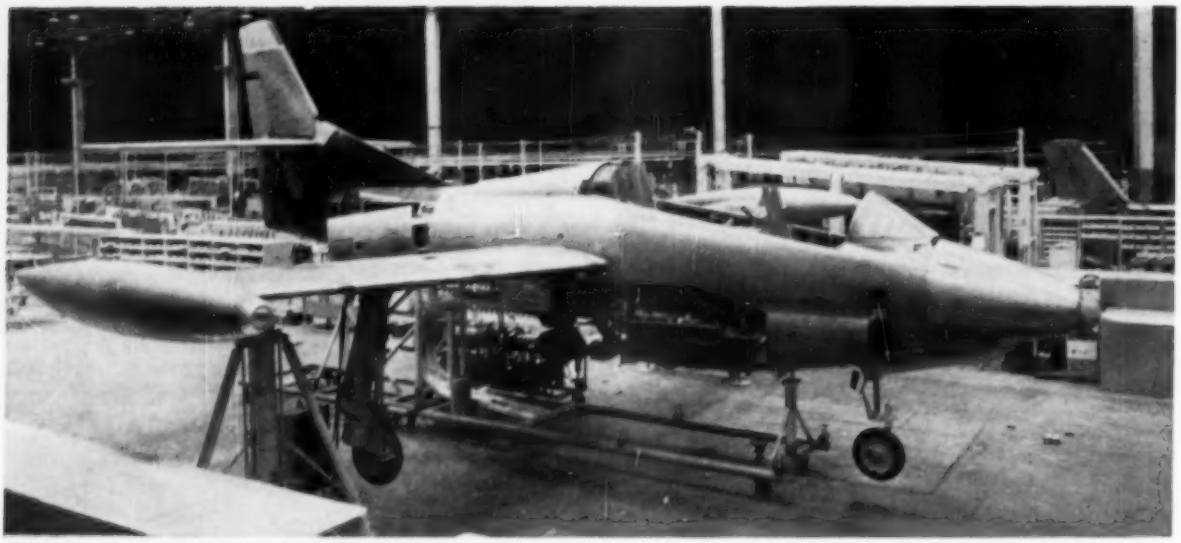
On right console are the cabin environmental and aircraft interior and exterior lighting controls. Ahead of this group is the flight control stick, and ahead of it are the selector buttons for the various map presentations desired on the horizontal situation display, and external fuel supply management controls.



XV-3 Is Tested at Ames

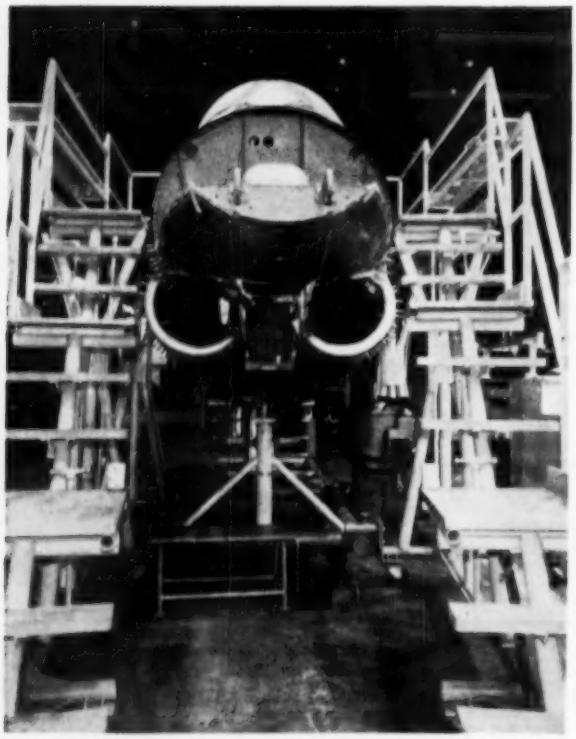
Two bladed rotor, a possible alternate to the original three bladed layout, is tested on Bell's XV-3 convertiplane at the National Advisory Committee for Aeronautics' Ames Laboratory wind tunnel (AW April 15, p. 23). Height of the rotor masts, however, has been returned to the original size after tests were made of various longer lengths. Airfoil shape of the rotor blades also has been altered, Bell said, but gave no details.



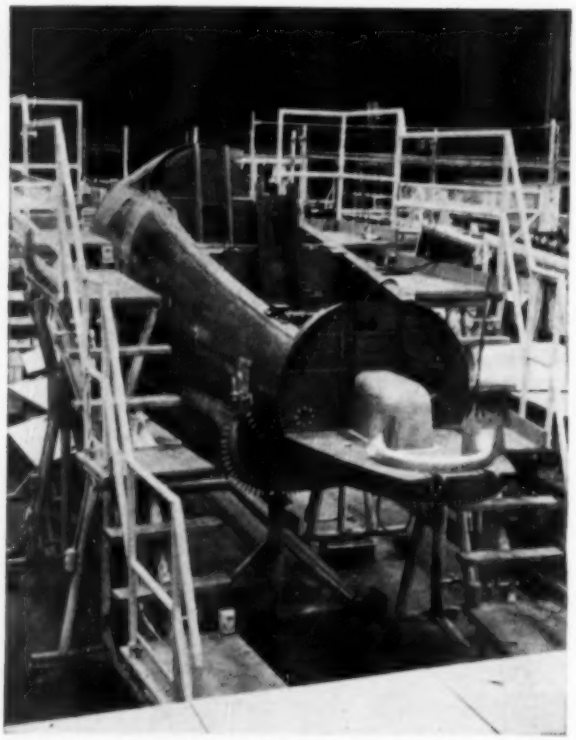


PLACEMENT OF INSTRUCTOR'S COCKPIT (rear) 10 in. higher than student's is emphasized in this view of partially completed prototype T2J-1, as are wide-spaced tricycle landing gear and placement of equipment in bays under cockpits for easy maintenance.

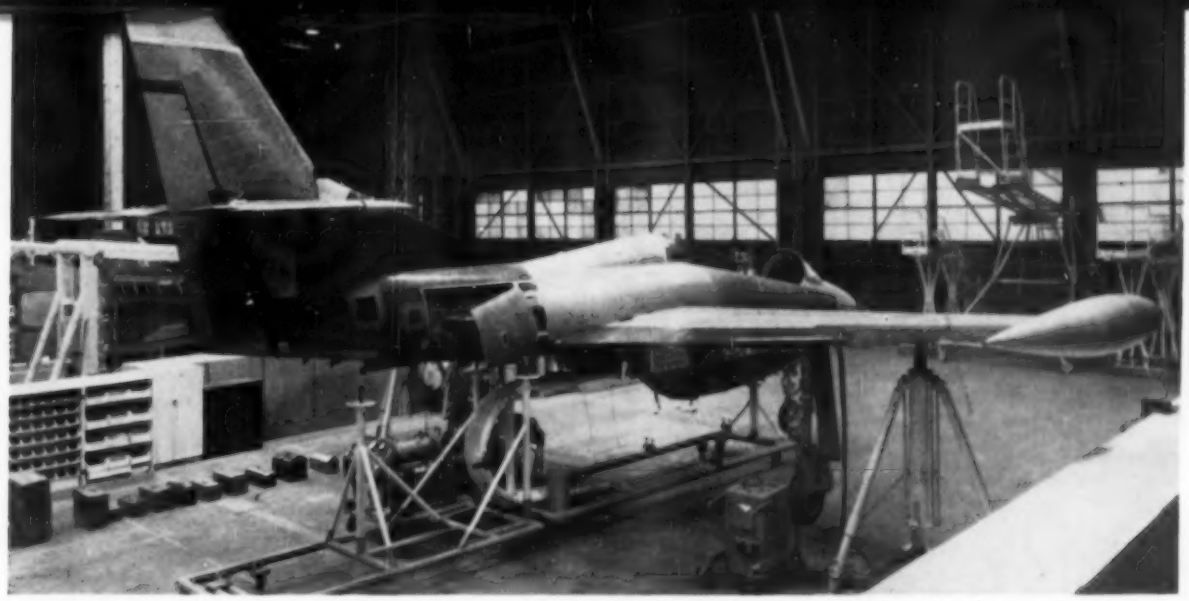
First T2J Photos Show Assembly, Structure



UNDERBELLY INTAKES for single 3,400-lb.-thrust Westinghouse J34-WE-45 turbojet straddle nose gear compartment. Steps and piping complex form part of the jig in which final assembly is carried out.



FORWARD PORTION of cockpit assembly has shelf in nose baggage compartment to allow placement of tray-mounted equipment systems such as gun-fire control or ILS units. Cockpits have ejection seat rails.

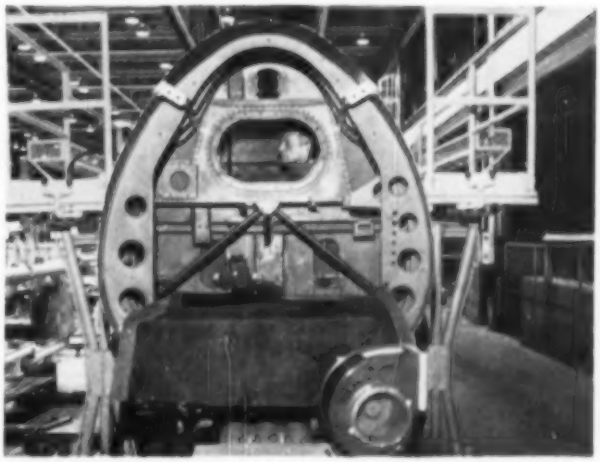


BIG TAIL is designed to provide positive control at low speeds; 45% of rudder is below horizontal tail to aid in spin recovery.

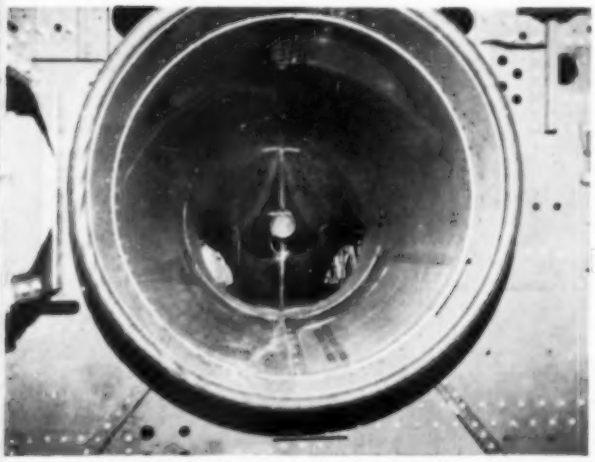
Prototype of new North American T2J-1 jet trainer for Navy is shown in final assembly at Columbus Division prior to roll-out, scheduled for Dec. 27. Airframe is shown virtually complete, awaits installation of equipment and mounting of Westinghouse J34-WE-46 turbojet under the fuselage, in these first pictures of the trainer (for detailed engineer story, see AW May 13, p. 52).

Designed to take students from primary through advanced phases, T2J-1 is first airplane completely designed at North American's Columbus Division. Export proposals have been made to number of foreign governments. Navy has given North American an initial contract for 26, it is expected that this will be boosted soon for a total of approximately 150 T2Js.

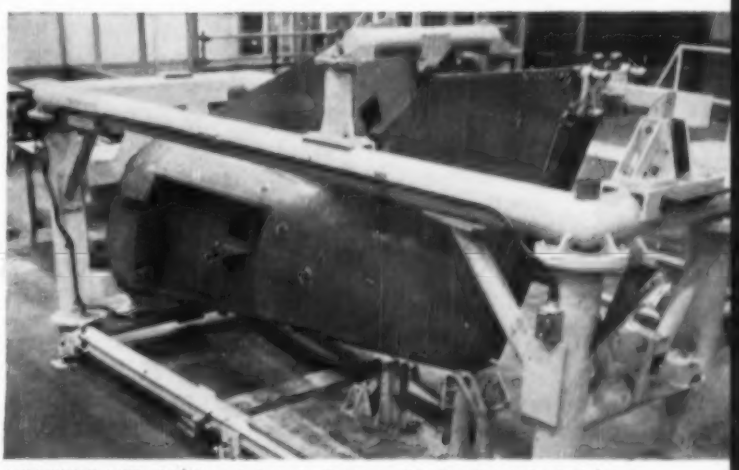
Design of the T2J incorporates many proven components to speed the development-to-production cycle and assure minimum amount of "debugging" in flight test. Westinghouse J34 was selected because of its record of 1,000 hr. to overhaul and low susceptability to foreign object damage due to all-steel compressor.



SECTION AFT of fuel cell later is spliced to aft fuselage section.



SPLIT INTAKES (forward) feed into single duct to provide flow to J34. A hatch at lower right permits inspection.



AFT FUSELAGE of T2J prototype in its heavy jig, showing cutout at lower left for hydraulically operated petal-type dive brakes.

Lockheed Laboratory Selling Liquid Helium

First commercial production of liquid helium on the West Coast is now under way at Lockheed Missile Systems Division's laboratory, Palo Alto, Calif.

Lockheed recently made its first sale of liquid helium—to Levinthal Electronic Products, Palo Alto, which is using the material (temperature: below −452F) to study the properties of scintillation crystals at low temperatures. The project is partially financed by the Atomic Energy Commission.

The Lockheed research facility plans to use liquid helium in its search for improved computing machine elements, rocket fuels and energy detectors. The liquid helium refrigerant is useful in rocket propulsion because it makes it possible to store energy.

Lockheed has lined up a number of electronics firms as customers for its liquid helium, which it would use in basic research.

Research conducted with liquid helium points to several possible applications. For one thing, it lowers metals to a temperature at which many of them become almost perfect electrical conductors, and scientists envision low-temperature instruments that would be super-sensitive and electric motors that would be 100% efficient. Also, liquid helium leaks through holes too small for any other liquid to penetrate, another property that might be exploited.

Among the devices developed with the help of liquid helium are the cryotron, a super-conducting electronic switch, and the peristatron, a super-conducting computer memory element.

Avro Orders Parts For CF-105 Arrows

Toronto—Avro Aircraft Ltd., Toronto, has placed orders for components for 40 Avro Arrow CF-105 supersonic all-weather jet fighter-bombers. Production of this newest Canadian aircraft (AW Oct. 21, p. 50) for the Royal Canadian Air Force is now underway, will total about $300 million.

Each aircraft is estimated to cost about $3 million. The first six production prototypes were estimated to have cost about $200 million. The aircraft has not yet been tested and toward mid-December was undergoing taxiing tests and final pre-flight tests.

Some 650 firms are holding subcontracts on parts for the Avro Arrow. The aircraft will replace the CF-100, now standard with RCAF squadrons.

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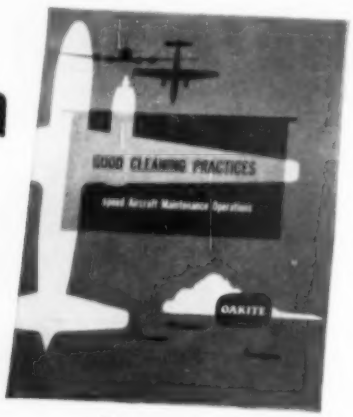

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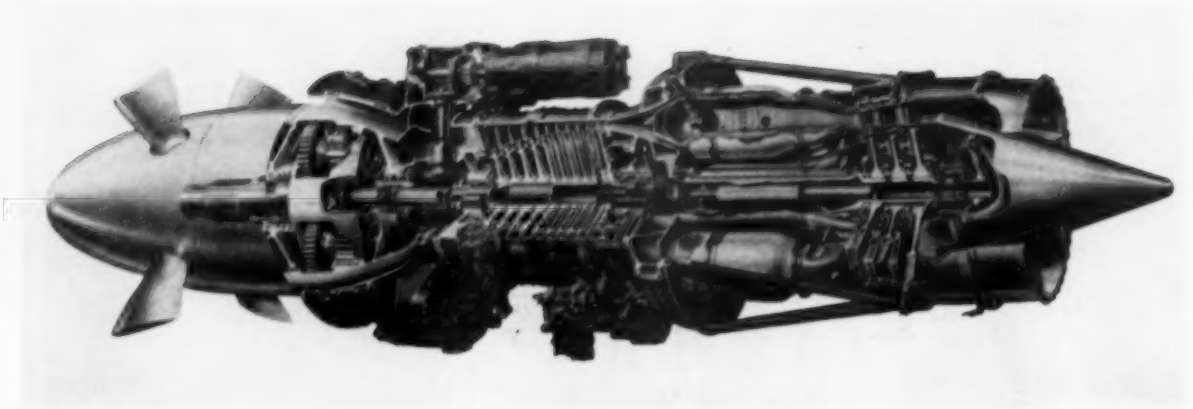
Bell Relocates Stabilizing Bar on XH-40 Helicopter

Latest configuration of the Bell XH-40 turbine powered helicopter is shown in this flight photo (above). Most obvious change from the early version is the positioning of the stabilizing bar above the rotor instead of below.

Bell engineers say that putting the stabilizing bar above the rotor gives the helicopter more stability and provides it with the handling characteristics of a fixed-wing airplane. XH-40 is lifting six loaded 55 gal. drums (right). Sling only encircles top barrel; lines tie the others together. Bell says the Army will call service test models of the XH-40 the HU-1.

These service test models of the HU-1 are now in production on an assembly line basis. XH-40 is currently in Phase III flight test.



ROTATING assembly is visible in this cutaway of the Napier Eland 3,250 eshp. turboprop engine. British fixed-shaft engine achieves a compression ratio of 7:1 from only 10 stages. Design incorporates automatic continuously variable inlet guide vanes.

Napier Pushes Convair-Eland Campaign

Los Angeles—D. Napier & Son Ltd. of England is pushing its international sales program for re-engining Convair 340 and 440 aircraft with Napier Eland turboprops.

A Convair 340 powered by Napier Elands is currently undergoing tests in Santa Monica, Calif., for Civil Aeronautics Administration certification. The test program is expected to be completed in February.

A 440 purchased new by Napier from Convair and which has been parked at Washington National Airport is about to be converted to Elands by Pac Aero Engineering Corp., Santa Monica. Napier says that after this 440 has been converted and certificated, it will be used as a courtesy aircraft: when a sale has been consummated, Napier will loan the 440 to the customer until conversion of the customer's plane is completed.

Probing Market

Meanwhile, Napier is talking to U.S. airlines, manufacturers and the foreign market. Efforts also have been made to interest the corporate plane market in conversion of presently owned 340s and 440s. Napier said it is currently approaching manufacturers to try to interest them in installation of Eland engines in planes now being produced.

Only concrete sale for the present is for conversion of three 340s owned by Real S. A. Transportes Aeros, the Brazilian airline (AW Nov. 11, p. 51). This contract is worth about $2 million.

En route to Santa Monica from England for certification, Napier's 340 was demonstrated at Ottawa before top level officials of the Royal Canadian Air Force. The officials observed, but Aviation Week was told that no action was planned.

The 3,250 eshp. Eland engines endow the Convair with an extra 2,000 hp. without increasing the existing engine weight and enable the machine to operate to its airframe structural limit of 53,000 lb. for takeoff. No airframe alterations have been made. The conversion exploits airframe design margins beyond the capacity of the original radial engines.

Performance Comparison

Comparing the performance of the Eland and the piston-engined version, Napier claims:

- **A 35-55 mph. increase** in block speed. Over a 600-mi. stage length the Eland Convair can take the original capacity payload of 12,900 lb. to 15,000 ft. and cruise at 275 mph. At this range the piston engine version is down to 10,500 lb. at 233 mph.
- **As much as** nine cents per mi. reduction in direct operating costs.
- **Four-fold increase** in capacity payload range which, with 12,900 lb., jumps the range with normal reserves from 250 mi. to 970 mi.
- **Increase in passenger** accommodation due to new forward position of propeller arc. Makes possible four more seats forward and two windows or, for tourist version, an aft lounge seating six.
- **Sixty per cent** reduction in climbing time in altitude.

These improvements, the company maintains, raise the profit potential of the Convair an extra $84,000 annually, based on a utilization of 3,000 hr., load factor 65% and stage length 200 mi. On an 800-mi. stage, annual earnings of a single machine should exceed the piston engine version by $140,000.

The company also points out that the standard load factor of 65% is likely to prove conservative as introduction of turboprop aircraft elsewhere has led to steep rises in route traffic, due to passenger appeal.

Napier assessments of DC-6 and Constellation 749 conversions prove less attractive because these aircraft are already operating to their designed gross weight. Block speeds go up 50-60 mph. and operating costs are reduced by about 10% but there is a reduction in the stage length with full payload.

With these three aircraft types, Napier estimates the total world conversion potential with spares at 4,730 engines and would be very satisfied with 25% of this business. The Eland conversion is presently estimated at $400,000. This compares with $450,000 for the Allison conversion which involves airframe modifications, Mr. Hampton, senior sales executive, told Aviation Week.

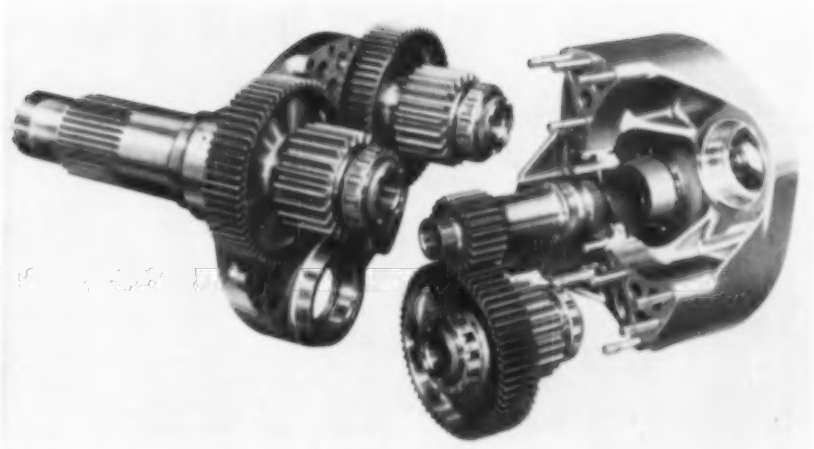
Brazilian Interest

Real eventually intends to convert its whole fleet of 20 aircraft. The Brazilian Ministry of Aeronautics has also shown interest in the project. But firm interest in the conversion extends to most other countries, including Japan.

In Washington, Napier has established the head office of a subsidiary—Napier Engines Inc.—and has appointed Pac Aero Engineering Corp. of Santa Monica as conversion contractors. Dallas Automotive of Dallas is to undertake engine repair and maintenance. The Eland Convair holds a special category certificate from the British Air Registration Board.

Decision to eliminate airframe changes was fundamental to the economics of conversion, and some per-

TORQUEMETER improves isolation of reduction gear from propeller vibration.



REDUCTION gear annulus has external tooth form which engages, with considerable flank clearances, in similar toothed fixed housing. Each tooth's mating flanks are isolated.

formance concessions were accepted. Structural changes are entirely confined to that of nacelle reinforcement forward of the existing engine bulkhead. Even the original nacelle diameter was retained though the turbine is only half the piston engine diameter. A reduction in nacelle diameter would have necessitated costly wing changes not justified by a two-knot gain in performance, and improved appearance.

A torque limitation to 3,350 equivalent shp. enables the aircraft to meet the engine-out-at-takeoff condition without any increase to rudder or tailplane surfaces. The engine has been developed at 3,500 hp. Power reserve helps compensate for 0.72% power loss per degree centigrade fall in ambient temperature.

Nacelle reinforcement consists of an increase in the number of stringers, boxing in of the existing channel section longerons and local increases in the nacelle skin. Nacelle top section was modified to accept the profile of the jet pipe and hot air muff—this having a smaller weight penalty than altering the shape of the pipe. Existing bulkhead was also stiffened to meet higher nodal moment and bigger jet pipe cutout. And a switch was made from aluminum alloy engine pickup fittings to steel.

Reduced wing loads due to lighter, more overhung engines are partially offset by the increased weight of kerosene fuel, but the zero fuel weight has been lowered from 45,000 lb. to 44,000 lb.

Design Features

Among the design features which, apart from simplicity, ease of maintenance and replacement distinguish this British fixed-shaft engine, is the achievement of a compression ratio of 7:1 from only 10 stages. Napier maintains it has the highest stage efficiency of any known compressor. Design incorporates automatic continuously variable inlet guide vanes. Operation is well removed from the surge line and a single-lever self-trimming control system provides a "slam" surge-free acceleration from flight idling to full 12,500 engine rpm. in only two seconds.

Gas inlet temperatures of 940C are also higher than have previously been used commercially. These two factors, backed up by some sophisticated lightweight engineering, lead to outstanding specific weight and cruising fuel consumption ratings of 0.5 lb./eshp. and 0.475 lb./eshp./hr. respectively.

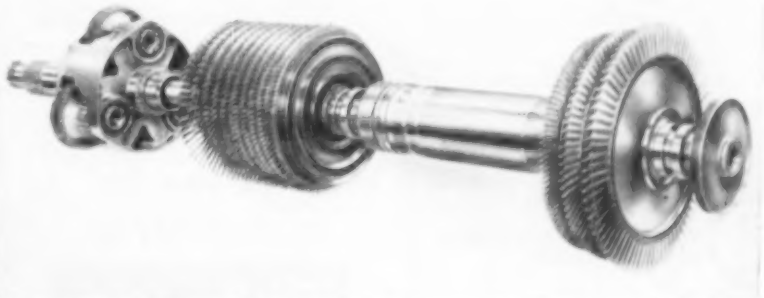
An extended fin-cooled turbine blade platform is used which reaches between the gas annulus and the disk fir trees. The platform considerably lowers maximum gas temperature felt by the disk, which can then be made of conventional ferritic disk materials in spite of the high gas temperatures. The blades are also laced from the platform, so the wire is taken clear of the gas stream. The latest Nimonic alloy is used for the first stage blades—Nimonic 100. A life of 1,000 hr. is anticipated for the turbine.

Aluminum bronze is used for most of the compressor blading because of its superior fatigue properties and because, being a bearing material, it minimizes the consequences of a casing rub.

Torquemeter Design

The torquemeter—mandatory on British engines—is of interest because it departs from the use of hydraulic pistons, saves weight and improves isolation of reduction gear from propeller vibrations. Annulus of the reduction gear incorporates an external tooth form which engages, with considerable flank clearances, in a similar toothed fixed housing. Sealing arrangements isolate mating flanks of each tooth. Pressure oil is fed to the clearance chamber between corresponding flanks when communicated with the opposite flank chambers through restricted passages across each tooth. The pressure differential across the tooth gives the torque loading to 1% accuracy. As the sun wheel also floats, the reduction gear and air intake are freed from all positive mechanical location with the engine and can be removed without disturbing the compressor.

Napier has also evolved a novel type



ALUMINUM bronze is used for most of the compressor blading because of its superior fatigue properties and because, being a bearing material, it minimizes the consequences of a casing rub. Napier says Eland has the highest stage efficiency of any known compressor.

Air Force Infrared measuring program chooses Barnes instruments

University of Michigan scientists using Barnes Far Infrared Mobile Laboratory on Pikes Peak.

The majority of participating groups in the Air Force's critical pioneering study on infrared radiation of background and targets selected Barnes infrared measuring equipment.

This equipment included Infrared Radiometers, OptiTherm® Far Infrared Cameras and low and high temperature Infrared Reference Sources. Barnes Engineering is the only commercial source for completely integrated radiation detecting and measuring instruments of this kind.

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roller bearing to accommodate relatively high shaft deflections arising from the lightweight construction adopted.

Details show how a small unloaded pilot track is used to shift a spherically mounted outer track of the main roller bearing so that it is always parallel to the inner track when the journal deflects.

This bearing detail was one of the few modifications called for since the engine first ran in 1952. Others include:

- **Switch from light** alloy to steel for first three compressor disk stages to meet centrifugal growth tendency; use of a magnesium compressor casing instead of aluminum alloy, which saved weight, and introduction of blowoff annulus and valve to improve starting and economical idling characteristics.
- **Turbine nozzle rings** dogged in casing replaced rigid fixing to allow for differential expansion.

Choice of upstream fuel injection knocked at least three inches off the engine's overall length. Adoption of unit construction speeds individual replacement of the reduction gearing and air intake, compressor, combustion chambers and turbine assemblies. The turbine can be replaced in seven minutes without disturbing the rest of the engine.

Lightweight engine mounting allows for easy packaged installation. The engine assemblies are attached to a rigid mounting plate in the region of the center bearing and pick up the nacelle structure at three points. Gyroscopic couples of the compressor and turbine assemblies are arranged to cancel at this center bearing in the mounting plate.

A tubular welded structure which extends from mounting plate to turbine casing relieves the turbine and aft section of the engine from bending loads. Replacement of a complete power package takes only one hour—replacement of the engine alone about eight hours.

Fuel Metering Unit

A Napier fuel metering unit in conjunction with propeller governor automatically compensates for changes in forward speed, ambient pressure and temperature, and prevents surging during transient load conditions. A variable datum turbine inlet temperature is also unusual insofar as it employs a mercury vapor circuit which sees the gas stream. Vapor is contained in a type of bourdon tube which elongates with very small temperatures in vapor pressure.

The piston engined aircraft was only cleared for light icing by the CAA. Napier feels that the additional hot gas flow from the Elands will obtain for the converted aircraft a clearance to maximum continued icing conditions.

"Many thousands of flight hours" is as specific as the company will be concerning flight development, but the chief development engineer said, "We have had only one engine failure in the air—and that was traced to a faulty track in one of the compressor bearings."

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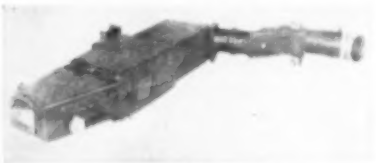


Voodoo Viewfinder

Viewfinder installed in four RF-101Cs which recently broke the transcontinental speed record (AW Dec. 9, p. 34), was used by the pilots to locate photographic targets and as a precise means of checking drift to help navigation. The device can look forward and below the aircraft. Usually, viewfinders offer a pilot his choice of two views, wide angle or narrow angle. However, the Voodoos are so fast that their viewfinders had to incorporate four views: three narrow angle and one wide angle. In addition to target location and drift angle indication, the viewfinder also computes photo interval rate for the pilot. Designated VF-31, the device is a product of Chicago Aerial Industries, Inc.

Production TT-1 Begins Flight Tests

By Craig Lewis

Dallas—Modifications designed to improve performance and simplify production and maintenance have been cranked into the production TT-1 trainer which went into flight test this month at Temco Aircraft Corp.'s manufacturing facility here.

First production TT-1 made its first flight Dec. 2 and will go through a three month flight test program at the Dallas plant. TT-1 will then go to the Naval Aircraft Test Center at Patuxent River, Md., where Temco will put it through another two months of flight testing before turning the new trainer over to the Navy.

First Aircraft

Navy accepted first production TT-1 in September and bailed it back to Temco for testing. Temco will finish work on its present production order for 14 aircraft by mid-1958. Order includes two airframes for static test along with the 14 production models.

Changes made in the design of the original TT-1 prototype and incorporated in the production model are all part of a general program aimed at cleaning the airplane up and making it easier to produce and maintain. The modifications have little effect on performance statistics of the Navy trainer.

One of the main aerodynamic fixes was made in the wheel well doors to correct a wallowing condition found in prototype flight tests. In the TT-1 prototype, the doors were open when the trainer was in landing configuration. On the production model, nose wheel doors are closed in the landing configuration.

With the new sequencing, nose wheel doors are open only in extension and retraction cycles. After extension, the doors are closed, leaving a small flap open to accommodate the nose gear strut.

Doors are now sequenced hydraulically. Inboard section of main gear doors has been extended a foot and is retracted when gear is down to keep the airplane as clean as possible.

Gear Redesigned

Landing gear has been redesigned so that main components are now interchangeable. High pressure tires have replaced the low pressure tires on the prototype, and a new internal disc type braking system is used in place of the prototype's external type. New braking system is automatically adjustable.

Redesign of landing gear has also increased the production model's tolerance for hard landings. Stroke on main and nose gear has been lengthened so the airplane can descend at a rate of 20.8 fps. in place of the rate of 18 fps. for the prototype TT-1.

FIRST production TT-1 takes off during flight test program which started early in December. Landing gear retraction cycle shows new sequence of wheel door opening. On the production TT-1, nose wheel doors and inboard main gear doors are closed both when the gear is retracted and extended. Doors are open only during the retraction and extension cycles. This new feature makes the Temco trainer cleaner during take-off and landing and cures a wallowing condition found in the prototype TT-1, which had its wheel doors open in the landing configuration.

Tail flutter which developed in the prototype was cured by redesigning the elevator trim tabs. Original version had one high aspect ratio tab on the left elevator which was actuated on the outboard end. Production model has a shorter tab in each elevator, and the new tabs are actuated in the middle by a direct linkage horn.

Excessive pitchup in the early prototype was traced to the clamshell air brake located on the vertical fin below the rudder. Pitchup was reduced and braking effectiveness increased by the addition of a third brake panel below the tail cone which opens downward.

Temco simplified production by switching to a bonded honeycomb structure for the leading edges of the wings, eliminating a hydropress operation and the use of 4,000 rivets in the built-up riveted sandwich leading edge used to save time in building the prototype. Honeycomb structure comprises 40% of the wing on the production TT-1.

Fuselage Link

Link between the tail boom and fuselage has been altered on the production version to give the fuselage more rigidity and make the tail boom easier to remove. Boom splice was moved back 25 in. to a position aft of the engine tailpipe fairing and changed from a four bolt type splice to a double ring forging configuration employing countersunk machine screws through ring forging flanges.

Prototype's automatic steps, which

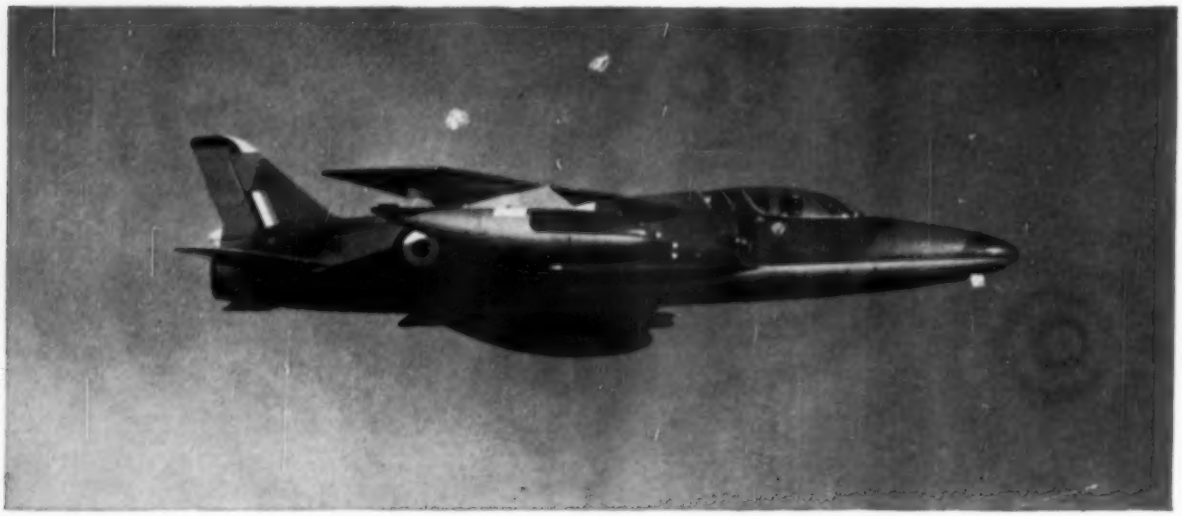
opened when the canopy was open, have been replaced by kick-type steps. The new steps are flush with the fuselage, and they are closed when they are not being used. This new feature makes production simpler, and it also eliminates danger of debris from pilot's shoes getting into nearby jet intakes during run-ups.

Among changes made to simplify maintenance was modification of the liquid oxygen system. Converter is a composite unit which can be changed quickly. Other TT-1 components have been made easily accessible to simplify maintenance.

With a series of five access doors, the whole bottom of the aircraft can be opened for maintenance on the hydraulic systems, control system and engine. Modification of the nose section allows mechanics to work on the nose gear from above instead of through the wheel doors. An access door has also been provided on the production model for the rear of the forward instrument panel and electrical units on the firewall.

Redesigned canopy jettison system is the main new safety feature on the production model. Changes were made to conform to Navy training requirements. Prototype's canopy was jettisoned by a pneumatic bottle; production model uses a ballistic charge. Canopy is jettisoned at the first stage of a two-stage face curtain. Seat is ejected at the second stage.

Instrument panels for both seats have been rearranged to bring them in line with Navy standards. Added safety devices on the panels include warning



Tiny Gnat Carries Big War Load

Tactical versatility of tiny Folland Gnat fighter-bomber is highlighted in these photos showing plane loaded with external stores, including a pair of 66-gal. auxiliary underwing fuel tanks and 12 three-inch rockets. Landing gear doors, bottom view, double as dive brakes to slow plane.

World's newest and fastest

Time: 9 December, 1957.

Occasion: the Eastern Joint Computer Conference in Washington.

Event: a major breakthrough of speed, quality, flexibility and cost reduction in the field of data processing and transfer.

Featured: the new device pictured above.

Known as the "Stromberg-Carlson Model 5000 High-Speed Electronic Printer," this equipment combines CHARACTRON® computer read-out tube, made by Stromberg-Carlson, and XEROX® COPYFLO® electronic printer, made by Haloid. Together, they translate stored electronic information into visual material —at 5 to 10 times the volume output of mechanical printers representing the same investment.

In operation, the CHARACTRON shaped-beam tube reads out and displays on its face the output of any data processing equipment—at speeds up to 10,000 characters a second. Acting electrostatically and with *dry* materials, these displays sensitize the surface of a selenium drum in the XEROX COPYFLO printer. The data are then transferred to a roll of paper, vellum or multilith master and come off the printing machine at the rate of 5,400 pages an hour!

Besides speed, many other advantages are inherent in the system. There is no intermediate processing, as with engraving or letterpress—*lower cost per page!* Manufacture of the "Model 5000" utilizes printed circuitry and transistors—*dependability!* Texts, graphs and business forms can be combined—*flexibility!* And computers whose idle time may be valued at as much as $300 an hour can be "emptied" in just minutes—*efficiency!*

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lights for low oxygen supply, low fuel boost pressure and fuel pump failure.

Production TT-1 has a completely new set of communications gear. System includes a new transistorized interphone system designed by Temco.

Prototype TT-1 was equipped with basic VHF gear for use during flight tests. Production models are equipped with UHF radio and ADF gear. Range of production TT-1's AN/ARC-52 UHF gear is greater than the operational range of the trainer, so students can't get out of touch with their base. UHF controls have been redesigned to give instructor override capability.

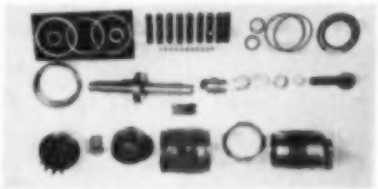
Antennas on the production model are also arranged in a new pattern. In place of the prototype's VHF antenna on top of the fuselage, TT-1 will have a UHF blade antenna under the fuselage below the forward seat. ADF antenna is buried under the engine well with a Fiberglas cover to cut drag.

Actuator Designed for B-58 Pod

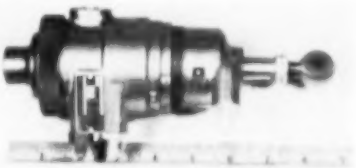
Aileron actuator for canceled Convair MX-1964 is constructed so that whenever hydraulic control pressure drops below a certain level, the actuator automatically carries the control surface to a neutral position where it holds it mechanically locked until control pressure is restored. Construction of actuator's mate, the upper and lower rudder actuators and the canard actuator is similar.

Actuator was made by Vickers, Detroit, Mich., under subcontract to Sperry Gyroscope Co. Convair MX-1964 was to have been a guided pod for the B-58 bomber.

For the air-launched missile this actuator may have been desirable either to guard against collision during separation or to prevent complete failure of mission if the missile were hit by enemy action near target. Specifications called for the titanium body actuators to withstand 250F ambient steady state temperatures and a thermal shock consisting of a 2-min. acceleration to 1,000F, a 2-min. dwell at 1,000F and a 4 min. coast to 250F. In a case where the temperature was produced by aerodynamic heating this would mean a Mach 4 missile launched from a Mach 2 mother ship.



DISASSEMBLED components (above) show makeup of left aileron actuator; below is complete assembly (right aileron actuator).



Military Aviation Financing

Following are details on the financing of aircraft, missile, and electronics programs by the three services for the first quarter of Fiscal 1958:

OBLIGATIONS

(In Thousands of Dollars)

	July 1 to Oct. 1	Unobligated Balance Oct. 1
AIRCRAFT		
AIR FORCE	$1,119,467	$6,683,043
NAVY	217,007	2,871,357
ARMY	—6,753	91,853
MDAP	54,114	939,926
TOTAL	1,383,835	10,586,179
MISSILES		
AIR FORCE	401,257	1,653,523
NAVY	28,330	648,940
ARMY	6,607	27,393
MDAP	.....	70,110
TOTAL	436,194	2,399,966
ELECTRONICS AND COMMUNICATIONS EQUIPMENT		
AIR FORCE	35,854	519,828
NAVY	15,048	291,800
ARMY	—2,339	5,339
MDAP	25,368	335,610
TOTAL	73,931	1,152,577

EXPENDITURES

(In Thousands of Dollars)

AIRCRAFT		
AIR FORCE	$1,524,713	$11,849,654
NAVY	574,587	5,295,254
ARMY	23,503	257,879
MDAP	214,516	1,024,823
TOTAL	2,337,319	18,427,610
MISSILES		
AIR FORCE	363,942	2,881,425
NAVY	72,179	967,589
ARMY	115,542	883,226
MDAP	842	70,110
TOTAL	552,505	4,802,350
ELECTRONICS AND COMMUNICATIONS EQUIPMENT		
AIR FORCE	134,461	1,135,083
NAVY	29,480	468,292
ARMY	39,887	344,178
MDAP	38,807	354,486
TOTAL	242,635	2,302,039

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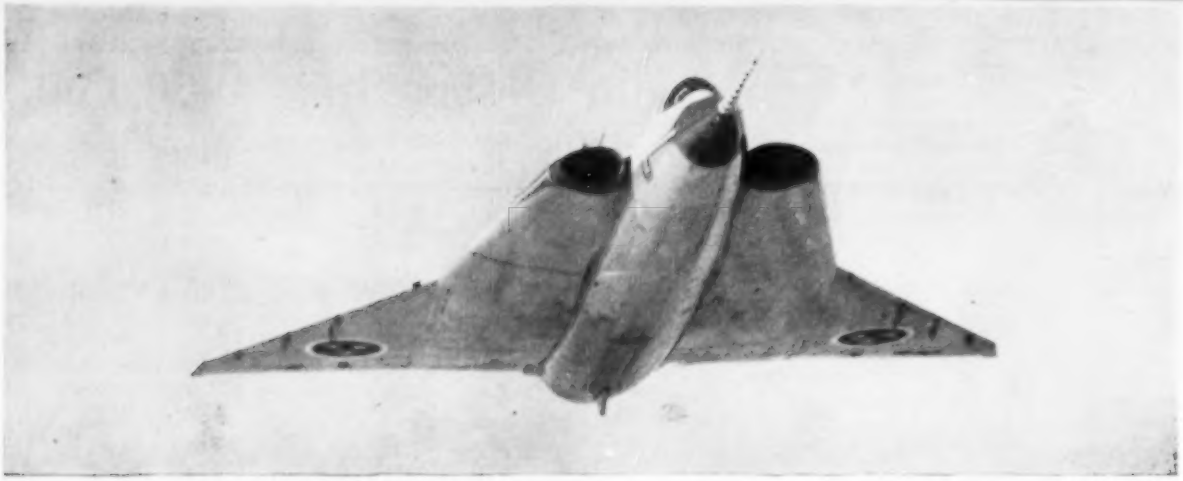
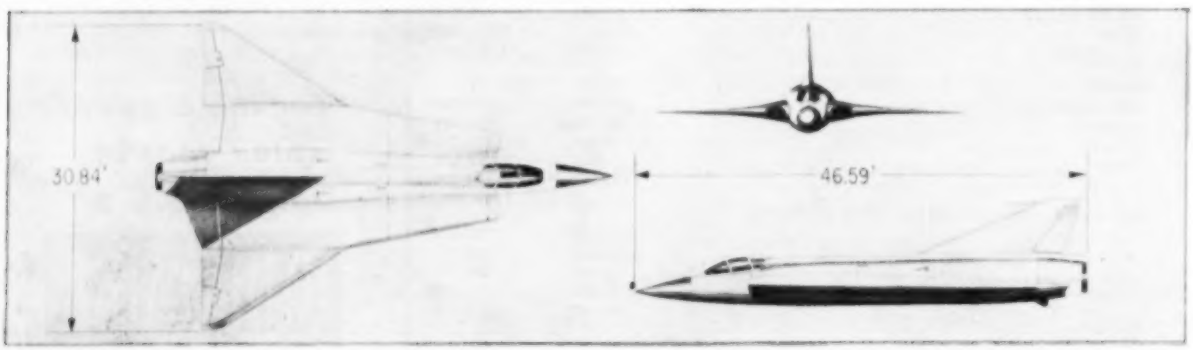


Swedes Offer J-35 to Other Nations

Saab-35 Dragon, chosen by the Swedish air force as its next standard aircraft, lifts off the runway on a test flight (top). Double-delta plane was designed as an all-weather interceptor, but will be developed through modifications to other missions, including ground attack. Stalling speed of the plane is about 115 kt., but is has been flown at altitude as low as 102 kt. Company says the J-35 can't be stalled under normal flight conditions. Landing with normal braking and drag chute gives a run of about 1,970 ft., and during a demonstration the plane was landed and brought to rest in about 1,480 ft. without over-heating the brakes. Three-view drawing of the Saab design shows its unusual aerodynamic layout (bottom). Saab is actively pushing the airplane in Europe as a low-cost, high-performance airplane with outstanding short-field characteristics. Strongest sales pitch is being made to the Germans and Swiss.



Scientists Explain U.S. Technical Lag

Washington—Senate Preparedness Subcommittee recently asked a number of U.S. scientists and members of the aviation industry to comment on the state of U.S. defense and scientific effort and the reasons for the lag behind the Soviet Union (AW Dec. 23, p. 20). The following replies were released by the subcommittee:

Simon Ramo

The Ramo-Wooldridge Corp.

"The missile and satellite programs of the nation have not used the scientific and engineering manpower of the nation to the fullest. Although this maximum has been approached in the case of the Air Force's Thor, Atlas and Titan programs, two other factors have existed on all programs, including the above referenced Air Force programs, that have limited the program prior to the exhausting of the full scientific manpower resources of the nation.

"These are (A) fund and facility limitations, and (B) the use of top scientific and engineering-management manpower to sell, justify, defend and otherwise be involved in nontechnical aspects to insure full appreciation, maximum sponsorship and continuation of the programs. Ultimately, the technical resources of the nation will limit our rate of progress in these and related fields, but today the much discussed 'shortage' of engineers and scientists has not been the bottleneck.

Bottlenecks Described

"In research and development work generally, the bottlenecks have been (A) too small a budget, (B) insufficient appreciation of the importance of research and development work planned and carried on well ahead of the commitment to a major weapon system, (C) well entrenched, bad habits to regard research and development as deserving only of minor sponsorship until and unless there is fairly complete evidence that a major new weapon system based on this research and development will indeed be successful and (D) the tendency to implement research and development out of procurement funds.

"As a general comment, it can be said that too large a fraction of the top research and development talent of the nation is engaged in nontechnical pursuits intended to assure the stability of the teams with which these top men are associated.

"The chief factor in determining where we stand in missiles and satellites today is the late starting date—late compared with when these programs could have been started. This late start resulted from years of established practices to mull over, argue out (often in an atmosphere of interservice rivalry), analyze, and committee-to-death the starting of any major project. We have had this dilemma: our pattern of operations has precluded committing to large projects early, when the job appears too speculative as to its final results; yet, we have not permitted large basic research and development expenditures that in the end constitute the only means for uncovering evidence as to the potential success of new concepts.

"It is a small exaggeration to state that the starting of our huge ICBM and IRBM programs resulted when they did, rather than a year or two later, only due to the accidental timely appearance in the right places of certain personalities of exceptional conviction, imagination and courage.

"The completion of the development, production engineering and production and the attainment of operational capability in the existing long-range ballistic missiles can best be assured by every possible support for the competent operating organizations already built up to handle these projects. It is too late now, and dangerous in the sense of potential dislocations and schedule slippages, to attempt a complete governmental reorganization for these specific projects that are now so well along. There is no way now to go back and start over again at an earlier date.

"However, with regard to all follow-on projects, including improved ballistic missiles and a variety of satellites and other space weapon systems, we will progress at a faster rate only if (A) very major changes are made in Defense Department organization to eliminate interservice rivalry handicaps, (B) separate funding is provided for these major programs, (C) new procurement and research and development policies are instituted that will permit large gambles, and (D) in the long run, relatively huge expenditures are committed compared with our present trivial ones for basic research (not tied to any specific military weapon system idea) and education.

"In connection with the presently existing ballistic missile projects that are nearing completion dates in the next year or two, a 10% or 20% increase in funds and a smoothing out of all organizational problems above the level of the operating organizations will be sufficient to provide the maximum of support.

"In the case of follow-on projects, a doubling of expenditures is required; and in the case of basic research and education, some tenfold increase is what is needed to maintain or insure superiority in our position with respect to the Soviet."

Homer E. Newell, Jr.

Naval Research Laboratory

". . . It is my opinion that a strong basic research program is essential to continuing vitality of applied research and development in missiles or any other military or peacetime applications. New facts, new ideas, new techniques, new materials, new instruments, all come from the basic research effort and are not forthcoming in adequate abundance when the basic research lags.

"Basic research is the search for new knowledge for the sake of knowledge and can be carried out only in that spirit. It should not be confused with applied research and development, the end products of which are prescribed, often quite rigidly, in advance. Nevertheless practical applications always come from broad, vigorous and sound basic research activities. These practical applications, however, come from unpredictable directions in unpredictable ways.

"In the case of missiles, satellites and manned space stations, one can list some of the basic research areas that must be strongly prosecuted to provide necessary support to the applied research, development and operations. These include: geophysics, particularly upper air research; solar research; astronomy and astrophysics; materials; propulsion; aerodynamics; medicine; law; rocket sounding and satellite research.

"A tremendous amount of time has been taken, during recent years especially, for the preparation and giving of briefings, reports, etc., in a struggle to keep basic research alive and to obtain the necessary support and funds. This has been particularly true in my own field of rocket exploration of the upper atmosphere. It is recognized that there will always be a need for this sort of thing, but in my opinion the amount of time required in recent years has been greatly excessive.

"In this country there has not been adequate effort in rocket sounding of the upper atmosphere. There have been many important scientific problems that have lain dormant because of lack of money and personnel to attack them. I would say that the national effort has been about 50% of what it should have been, considering these important problems that have remained dormant. At the Naval Re-

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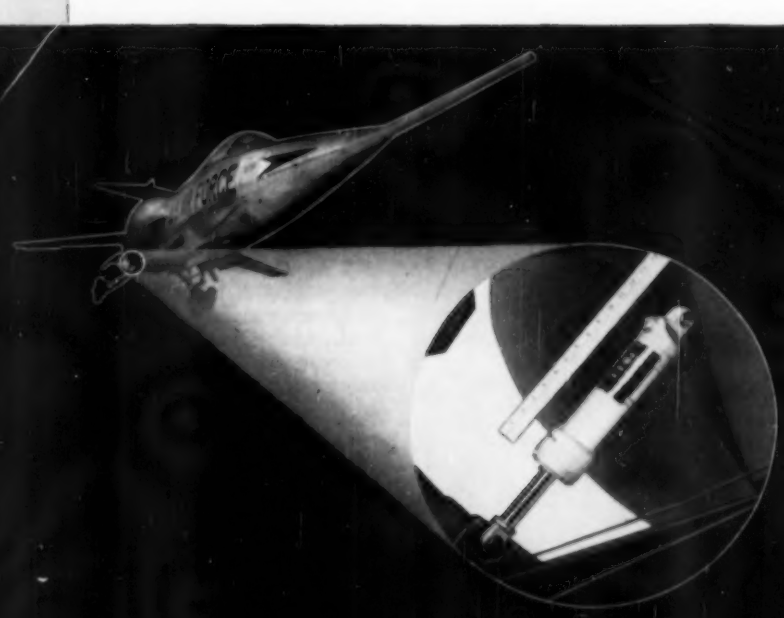

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Weight with Oil: 144 lbs.
Piston O. D. = 4.75 in.
Static Inflation Pressure 8010 psi.

THREE PRESSURE-RANGES OF AEROLS SHOW BENEFITS OF HIGH PRESSURE

Comparison of (left) standard low-pressure AEROL, (middle) medium-pressure AEROL and (right) high-pressure AEROL. Note reduction in diameter of shock-absorber package.

Paratroopers Jump From C-130As

Paratroopers of the Army's 82nd Airborne Division participate in a mass jump from USAF Lockheed C-130A Hercules turboprop transports over Drop Zone Sicily, Ft. Bragg, N. C. Twenty-five aircraft dropped 1,000 paratroopers in 10 min. during the exercise.

search Laboratory the effort, because of lack of money and personnel, has been less than 50% of what it should have been on the above basis.

"The bottlenecks that I have encountered have been of three types: (A) administrative, (B) lack of money and (C) lack of personnel. Actually there is considerable overlap between and among these categories.

Viking Research

"The Viking, which was begun in 1946, was developed as an upper air research vehicle. The rocket itself, the techniques learned, and the associated equipment developed, formed the nucleus for further development into a ballistic missile system. Nevertheless, NRL never could obtain the financial support to carry out such a development. In 1952 the Laboratory pointed out to the Navy the importance of ballistic weapons to military preparedness and showed in detail how the Viking experience and hardware could be used as the basis for the development of a medium range ballistic weapon usable from land, ship or submarine. But such a project was never funded.

"When the ballistic missile proposals failed to receive support, NRL decided to use the Viking as a supporting research vehicle to obtain data important to missile development. Because of its costliness it was difficult for NRL to fund this project, and, since appeals to both the Navy and Air Force brought no support, the project was about to go under, when the Vanguard program came along. It was the Viking experience and hardware that put NRL in a position to undertake the Vanguard work.

"Basic research in the Department of Defense suffers by being swallowed up in and made subservient to applied research and development programs. It suffers in competing with such programs for money, personnel, facilities, and support in general. What is needed is a permanent, competent and adequate staff of scientists at the DOD level to provide leadership in basic and applied research. By leadership I do not mean detailed direction; I mean the actual doing of high quality, imaginative, comprehensive, and dynamic research, the participation in scientific pioneering.

"In my opinion a purely coordinative office that is not involved in the doing will not be effective. By adequate staff, I mean something in the nature of a complete laboratory covering in a broad way physics, chemistry and engineering. In asking that such a laboratory be placed at DOD level I am looking to securing a position for it where its leadership can be asserted within the military, where the needs peculiar to basic research can be protected, where the funding can be sufficiently stable for sound planning and operation, and where close liaison with the military can still be maintained. Laboratories like the National Bureau of Standards and the U. S. Naval Research Laboratory have the breadth and depth of competence and activity to provide the leadership required were they properly placed organizationally. But NRL, unfortunately, is buried at the very bottom of the administrative heap in the Navy's Office of Naval Research.

Money Crimp

"NRL has made a continuing effort to keep the costs of its rocket sounding program down. One approach which promises to reduce costs by large factors is the development of the Arcon and Iris rockets. Lacking Navy support for these developments, NRL found a non-DOD sponsor who agreed to fund the developments to their conclusion. Some funds were transferred to NRL, but at this juncture DOD and the Bureau of the Budget told the sponsor to leave the rocket development business to DOD. But DOD did not provide the funds needed, and the Arcon and Iris efforts ground to a halt. Arcon would have died had not the Navy learned that the Army was going to pick up the work, whereupon the necessary funds suddenly became available.

"Iris did come to a complete halt and would have died had not NRL with great difficulty made available enough funds to get it moving again. More funds will be needed to exploit Iris potentialities to their fullest, but where the monies will come from is not known. It should be pointed out that the Arcon and Iris not only will be much cheaper than previously used sounding rockets of comparable performance but also are genuine technological breakthroughs in the solid propellant rocket field. In spite of this they must struggle for their very existence.

"The rocket upper atmosphere research program was a necessary prelude to satellite research. At the present time, vertical rocket sounding and satellite research are complementary meth-

ods of doing space research, the former must be used for studying the atmosphere along a vertical cross section while the satellites provide platforms for making measurements at fixed levels above the atmosphere.

"The upper air rocket research program at NRL has always received strong support from the Laboratory administration. The cost of the program, however, is about twice that of a normal laboratory research program, because of the need for rockets, launchers, telemetering ground stations, special airborne equipments and expeditions to remote locations such as the Arctic, the Antarctic, and the mid-Pacific. The cost is about $45,000 per man per year as opposed to about $25,000 per man per year for normal research. As a result, a large fraction of the rocket sounding program has never been covered in NRL's annual budgets.

"To do so would have required sizable reductions in the Laboratory's staff, which in turn would have destroyed the breadth of competence which is the Laboratory's great strength. Instead, rockets, telemeters, ground stations, etc., have been purchased out of whatever balances happened to be left toward the end of each fiscal year. Appeals to the Navy for relief from this situation have been of no avail. This hazardous fiscal policy forced upon the Laboratory has prevented sound planning for and execution of the program. What has been done has been accomplished in spite of these blocks.

Sounding Program

"Because of the fiscal policy that lack of higher level support forced upon NRL in connection with its rocket sounding program, this program was about to go under several years ago, in spite of the fact that its accomplishments had shown the NRL program to be the most comprehensive and productive such effort in the country. The program would have gone under at that time had not the International Geophysical Year rescued it. At the present time, this program continues because of IGY rockets and equipment bought by the National Science Foundation. No funds are available however, to purchase more rockets and equipment for continuing this research beyond IGY, even though there will remain many important problems to solve. To maintain continuity in the program, these new rockets must be ordered now so as to be available at the end of the current IGY effort.

"The personnel in this program are highly competent scientists, and are constantly beseiged with offers of jobs in industry and elsewhere. Salary increases between 30% and 50% are quite common. These men stay with the project, however, because of scientific interest, because of its dynamic and challenging nature and because they believe they are doing something important while the proffered jobs usually would take them out of the basic research field entirely. The present lack of monetary support for the program, however, has become obvious to all and is a source of concern. Many of the men, including top level key personnel, are now looking about to decide where they should jump when the program goes under, if it does. Time is of the essence if the program and the staff to do it are to be saved.

"The NRL rocket sounding program started with enough people to conduct a comprehensive program that covered most of the important research problems in the field. In the case of upper air research, this is essential because the various phenomena involved—pressures, temperatures, densities, winds, ionosphere, magnetic fields, the aurora, airglow, cosmic rays, the solar radiation input and meteors—are all so interrelated that an understanding of one aspect requires knowledge of all the other aspects. For the past five years, however, the rocket upper air program has operated at or below half the necessary strength to do the job right. Besides the obvious effect of lowering the total effectiveness of the program, this understaffing imposes extra burdens and strains on the personnel who are available since they naturally extend themselves in a commendable but impossible effort to make up for the deficiency in manpower.

"This country's position in the field of space research would be greatly strengthened by the creation of a National Space Establishment. . . . Some of the things that such a National Space Establishment should do are:

Space Exploration:

- Vehicles.
- Electronics systems.

Supersonic Wind Tunnel

Control room of the Boeing tunnel with the model support section rolled back out of the 4 ft. diameter test section for installation and instrumentation. The tunnel's flexible nozzle, out of sight to the left of the test section window, is formed by flexible steel walls which can be hydraulically jacked up from openings as large as the test section down to 1-ft.-square test sections for higher supersonic flows. Fourteen data channels and analog computers in foreground record and analyze strain gaged deflections of model.

Boeing Aircraft Co.'s new wind tunnel at Seattle, Wash., pumps up two 38 ft. diameter spheres to 147 psia. for 5-to-25 sec. blow down runs. Downstream of the spheres can be seen the settling chamber, nozzle section, test section with its 30 in. diameter viewing window, and the sound absorbing exhaust section.

- Communications.
- Tracking.
- Guidance.
- Controls.
- Power.
- Logistics.
- Operations.
- Astronautics.
- Medicine.
- Law.
- Applications.

Space Research:

- Vehicles.
- Electronics systems.
- Logistics.
- Operations.
- Earth's atmosphere.
- Moon.
- Interplanetary phenomena.
- Sun.
- Planets.
- Stars.
- Interstellar phenomena.
- Extragalactic observations.
- Applications.

"One of the first things that should be done is to strengthen the present rocket sounding program, and to put it on a sound basis financially.

"It is my feeling that something similar to what the Rocket and Satellite Panel has recomended for space research would be very effective in the missile research and development field also.

"I should like to conclude with a few general remarks. First about salaries. I believe that a raise in salaries for scientists is necessary, but I do not believe that the government has to match the salaries of industry. The government can retain competent, top quality scientists by providing (A) the opportunity to do research and engineering in dynamic, pioneering programs that are adequately supported and (B) an adequate salary for the scientist to live in reasonable comfort and to provide his children with a good education.

"Secondly, government facilities can provide research opportunities that private enterprise cannot fit into a reasonable profit and loss scheme of things. Because of this and because of research freedoms that the government can afford, the government can get research men at lower salaries than industry, and thus can do research at a lower overall cost. On the other hand, nothing is gained if the costs are reduced to the point where the government cannot attract and retain the top level of competence.

"Finally, it is my opinion that the military have strayed too far from their primary job of defense in which they are a user of research and research prod-

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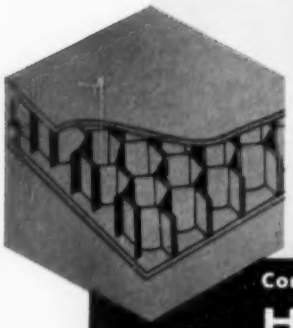

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ucts, and are attempting to prescribe the research that is to be done and even to direct the research itself. On both counts the military are incompetent to do the job. The Office of Naval Research and especially the Naval Research Laboratory have traditionally had less military interference of this type than other Defense establishments with which I am familiar. The high productivity of NRL, which includes many important military applications, is strong justification for civilian scientific direction of science programs free of military interference. Let me hasten to add, however, that it is recognized that there must be close liaison and cooperation between the scientists and the military."

W. C. Tinus
Bell Telephone Laboratories Inc.

S. C. Donnelly
Western Electric Co. Inc.

"1. There is need for more concentration of responsibility and authority.

"More concentration would reverse the present trend toward increasing numbers of people in government who must be informed before decisions can be reached. This applies to both project work and associated facilities. Once it is decided to proceed with a particular project, a single individual backed by a competent organization should have the responsibility and authority to carry out the development and production of the weapon system as a whole. His responsibility should carry through until the weapon system is in effective operational use. A situation approaching this obtained in the early days of Nike.

"2. Use of overtime should be at contractor's discretion.

"While recent restriction of overtime has not yet seriously affected our projects, it would seem wise for the future to allow contractors to use overtime as required to meet obligations.

"3. Longer term authorizations would be desirable.

"Longer term funding would in many instances permit more expeditious and efficient management.

"4. Reduction in the amount of required paper work would speed progress."

J. A. Van Allen
Department of Physics
State University of Iowa

". . . I believe that there is adequate scientific, engineering and technical manpower in the U.S. missile and satellite field. There now exists a vast technology in the United States which can be applied to agreed national objectives. However, the administrative handling of this potential has been painfully divisive and painfully lacking in clear, unified objectives. The very roster of missiles under development by the several services is prima facie evidence for the diffuseness of national effort and for the lack of concentration of this effort on primary needs.

"In the satellite field, it would have been technically feasible for the U.S. to place satellites in orbit at least as early as October 1956 using the Army's Jupiter C. But the Army's proposal to do this was voted down within the Defense Department (in summer 1955) in favor of having the Navy undertake the development of a complex, new vehicle for the purpose. This decision, which has been actively contested by some of us throughout the past two or three years, was defended in terms of not interfering with direct military developments.

"However, the true overall effect has been exactly the reverse—since a fresh set of difficult missile developments was imposed on commercial contractors (Glenn L. Martin Co., Aerojet Engineering Corp., Grand Central Rocket Co., etc.) who were already deeply involved in the development of purely military vehicles. The proposed Jupiter C system was to be assembled of rockets and other components already in existence in 1955. This system was

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convincingly demonstrated to be capable of placing a 15 lb. payload in a satellite orbit as early as September 1956. Even after this famous flight the issue was treated by the Defense Department as too delicate to mention, lest the precarious balance of interservice rivalry be disturbed.

"I regard the Navy's Vanguard program as in competent hands (despite vastly over-publicized difficulties, such difficulties being actually normal in this difficult field). But I regard the DOD's decision to proceed with the Vanguard development as thoroughly ill-advised.

Civilian Commission

"The United States has an urgent need for the genuine unification of its missile and satellite efforts in a civilian commission having the general character of the Atomic Energy Commission. The essential features of such a Missile and Satellite Commission are as follows, in my judgment:

- **It should have a statutory status** independent of the Department of Defense.
- **The military services should** be regarded as customers (as with the AEC) but they should not possess direct control over its program, nor should their customer-demands preclude a vigorous program on longer term scientific and civilian applications.
- **It should have adequate funds** provided by specific congressional action.
- **It should operate, by contract,** one or more centralized laboratories, necessary proving grounds, and other major facilities required.
- **It should have,** via the President, adequate means for requisitioning the services of military bases, ships, personnel, equipment, etc. as required.
- **It should give such a level** of support to the scientific and civilian applications of missiles and satellites as seems appropriate to the long term national welfare. Much of this support would likely take the form of contracts to universities and to other civilian research establishments. Only in this way can the scientific resources of the country be developed in an imaginative and profitable way for the long-term exploitation of the vital new field of exploring space and using the results and the techniques for human benefit. (The military applications, though of most immediate importance, are quite narrow and limited. Note the similarity to the work of the Atomic Energy Commission.)

Dr. Ernst Stuhlinger

ARMY BALLISTIC MISSILE AGENCY

"1. **Question:** With respect to the missile and satellite programs, has there been an adequate and proper use of scientific manpower? If the answer is no, please explain.

"**Answer:** With respect to missile

programs, there was a severe deficiency in the area of supporting research. Supporting research, as contrasted to basic research, is specifically undertaken to improve existing systems and to prepare future development projects. This kind of research work should be initiated by the engineers and scientists who are actively engaged in development projects. The actual work would be done to a small part within the development projects and to a greater extent by subcontractors. Ample capabilities for the initiation of such supporting research work exist at the Army Ballistic Missile Agency and at similar installations in the country, and a great many subcontractors would be eager and capable to carry out such work. However, there was practically no assignment, and by far not enough money, to initiate the urgently needed research work. Our country will continue to be poorly prepared for missile, satellite and space vehicle development projects unless the existing manpower for supporting research is utilized to a greater extent. Organizations like the Army Ballistic Missile Agency should be given a permanent research assignment to "advance the state of the art" without further specifications, but with a fixed and substantial amount of funding which is available regularly year after year.

With respect to satellite programs, the only project of this kind is Vanguard. It was accepted in 1955 from the Navy in preference to a satellite project proposed a little earlier by the Army. The reasons underlying this decision are a matter of record (deliberations and suggestions of the Stewart Committee, summer 1955). Since the satellite capability of the Army was a direct outgrowth of an existing special flight test program, it continued to exist even though the satellite proposal was not accepted.

"The first Army satellite could have been launched in fall 1956. During 1956 and 1957, a number of offers were submitted by the Army Ballistic Missile Agency through Army channels and through members of Project Vanguard, suggesting that the Army proposal be accepted as a second source solution. The fact that none of these proposals was accepted until very recently shows that existing scientific manpower was not used properly and adequately with respect to the United States satellite program.

Missile Bottlenecks

"**2. Question:** With respect to the missile and satellite programs, please outline the bottlenecks, if any, which you have encountered in research and development work. If possible, please give specific examples.

"**Answer:** When the IRBM, ICBM and satellite projects were initiated a few years ago, a number of technical problems existed which at that time had not been solved. Among them were rocket motors of sufficient power and reliability; a protective cover for a re-entering nose cone; a guidance system for long range missiles; vehicles powerful and precise enough to launch satellites; methods to calculate satellite orbits from observational data, and others. Today, solutions for all of these problems exist which are satisfactory at least for the time being.

Although the technical solutions of these and similar problems normally determine the rate of progress of a development project, the decisive bottlenecks encountered during recent years at the Army Ballistic Missile Agency were caused rather by the lack of a clear-cut assignment of an IRBM or satellite project; by the uncertainty whether IRBM work would be carried on or discontinued soon; and by the lack of manpower, funds and assignment for supporting research.

"**3. Question:** With respect to the missile and satellite programs, please outline any other bottlenecks which in your experience have impeded the development and production of missiles and satellites. If possible, please give specific examples.

"**Answer:** In general, 'too little' was done 'too late.' The assignment of new projects, instead of pushing vigorously the advancement of the art, followed only anxiously the momentary requirements of one of the services. The development of more powerful rocket motors should have been initiated years ago. The two existing IRBM projects, Thor and Jupiter, have been living for a full year under the threat that one of them would be discontinued soon. Instead, both should have been pushed forward, the one to fill the immediate requirements of the armed forces, the other one to form a powerful nucleus for further development.

Too Much Secrecy

"To some extent, development was impeded by too much secrecy at the wrong places. Allotment of funds and personnel spaces, and assignment of new projects, should be made on the basis of past accomplishments. If these accomplishments are not known to the alloting committees, or to those who

Hiller Vehicles Perform for Army

Army helicopters built by Hiller Helicopters, Palo Alto, Calif., are flown in review formation. From left to right are the Army's H-23D helicopter; Army H-32 ramjet, which is undergoing evaluation; the ultra lightweight H-32, and the one-man collapsible Rotorcycle. Officials of the Army and Hiller are watching the demonstration.

Aircraft and Related Procurement Funds

Air Force and Navy obligations for aircraft and related procurement, which reflect new contracting, were down during the first quarter of the current 1958 fiscal year as compared with those of the same fiscal 1957 period — $2.8 billion as opposed with $1.7 billion. Expenditures were up — $2.5 billion for the first fiscal 1958 quarter, compared with $1.9 billion for the first fiscal 1957 quarter.

OBLIGATIONS
(In Millions of Dollars)

	First Quarter FY 1957 (July 1 to Oct. 1, 1957)	First Quarter FY 1958 (July 1 to Oct. 1, 1957)	Unobligated Balance Oct. 1, 1957
AIR FORCE	$2,009	$1,529	$8,953
NAVY	839	229	3,394
TOTAL	2,848	1,758	12,347

EXPENDITURES

			Unexpended Balance Oct. 1, 1957
AIR FORCE	$1,504	$1,910	$15,297
NAVY	411	614	6,201
TOTAL	1,915	2,524	21,498

influence the decisions of the committees, wrong decisions are unavoidable.

Lack of knowledge of successes and achievements has obviously caused misjudgments of the capabilities of the ABMA during the past year.

Vanguard Criticism

The difficulties in the Vanguard satellite project are caused, at least to a great extent, by the unrealistic attempt to carry out such a big project as a strictly scientific venture, without taking advantage of existing military projects.

Had the satellite project been made part of a military project, it would have drawn the greatest benefits from the experience of an integrated team, from the availability of flight proven components and from an almost unlimited growth potential. The scientific purpose of the IGY satellite could not have been served better than by a combination of a scientific team like the upper atmosphere research panel and a guided missile team like the Army Ballistic Missile Agency.

Acceleration

"4. **Question:** Please outline any recommendations which you may have for accelerating the development and production of missiles and satellites.

"**Answer:** The Rocket and Satellite Research Panel, which is affiliated to the National Academy of Sciences, recently completed a plan for a national space establishment, an organization directly under the executive branch of the government which would plan, direct and budget all the development projects related to missiles, satellites and space vehicles. The Senate Preparedness Investigating Subcommittee has been informed of this plan. It incorporates a proposal which suggests the maximum possible use of all existing guided missile development teams for an integrated development program. This plan visualizes guided missiles for immediate military use; guided missiles for future military use on the Earth, carrying warheads, reconnaissance equipment, freight or troops; carrier vehicles for orbital missions; unmanned and manned satellites for military use and for peaceful applications such as global weather survey, early storm warning, television relay stations, and communications; vehicles for unmanned and manned exploration of the Moon, and systems for planetary exploration. Particular attention is given to the extremely important interrelation between scientific research work and the development of systems for military use. Even though the greater part of the scientific experiments will be made without direct military purpose, the military will take the richest harvest from scientific research work. Scientific missile and space projects should therefore not be separated from military projects. Scientific projects deserve the best experience, the best components and the best facilities which are available, and military projects should have the full benefit of the advanced thinking and experimenting of the best research scientists. Without a complete mutual integration of military and scientific missiles, satellites and space vehicle projects, both of them will suffer unduly.

The National Space Establishment should have the benefit of the advice from the development teams, but it should make its decisions only on the basis of foresight and optimum use of existing capabilities.

Inter-service rivalry should not influence those decisions.

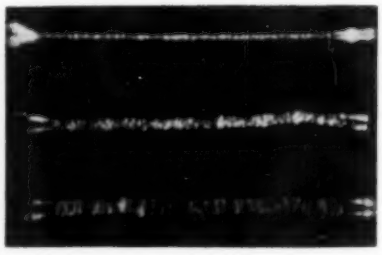
Project assignments should not be made according to services, but according to development teams.

The capabilities of a team should be judged only from its real accomplishments, and from the length of time it has been involved in successful development work, but not from mere paper studies or from the boldness with which ultra-short development times are promised.

There is ample experience now in this country to realistically estimate the time necessary for the development, lab testing, flight testing and completion of a missile project.

This experience should be utilized to the fullest extent.

Above all, it should be realized that research and development teams are the most valuable asset a country can have on its defense account. Full utilization of all of them according to a well-conceived master plan will not only be the wisest, but, in the long run, also the cheapest approach to our defense problem."



Exposure Time: 5-Billionth of a Second

Photo shows three aluminum wires 1/1,000th of an inch in diameter and ¼ in. long during electrical disintegration. Effective exposure time for each shot was five-billionth of a second. Explosion of the wires was photographed at three phases of the disintegration process: 20-, 30- and 40-billionth of a second after the discharge started. Feature of the ultra high speed camera which took the pictures is a hermetically-sealed, large aperture, wide angle Kerr cell shutter which has no moving parts and is pulsed electronically to obtain very high speed exposures. New developments of the camera may allow it to take pictures with exposure time of only a fraction of a billionth of a second. Camera was developed by Electro-Optical Systems, Inc., under a U. S. Army Ordnance contract for the Samuel Feltman Ammunition Laboratories of Picatinny Arsenal, Dover, N. J.

Wind Tunnels Favored in Ejection Test

New York—Wind tunnels are in many respects superior to rocket-propelled sleds for testing the behavior of personal flight equipment under actual ejection conditions at transonic speeds, according to the Martin Co.

Martin Human Factors Section personnel reached this conclusion after comparing results of recent Martin-conducted rocket sled tests of personal flight equipment at the Naval Ordnance Test Station, China Lake, Calif., and subsequent tests of similar equipment made in a wind tunnel at Air Force's Arnold Engineering Development Center, Tullahoma, Tenn.

Latter tests were made under Navy sponsorship in cooperation with USAF Air Research and Development Command.

Problem posed by the Martin tests was that, to get the necessary air pressure to simulate a Mach 1 condition and dynamic pressures of 2,000 psf., all the air pressure output from the entire Arnold Engineering Development Center facility had to be diverted to the Martin test cell. This resulted in shutting down all other wind tunnel tests while Martin tests were being conducted.

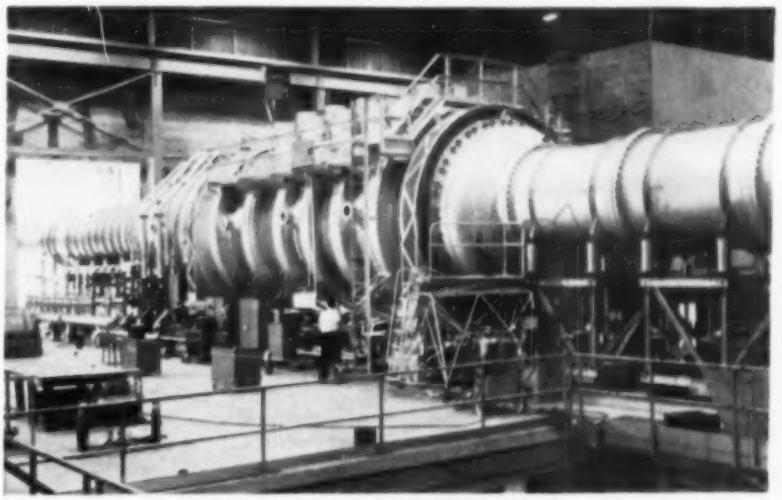
No Accurate Analysis

Reasons given by Martin technicians for trying a wind tunnel to test personal flight equipment rather than a rocket sled were:

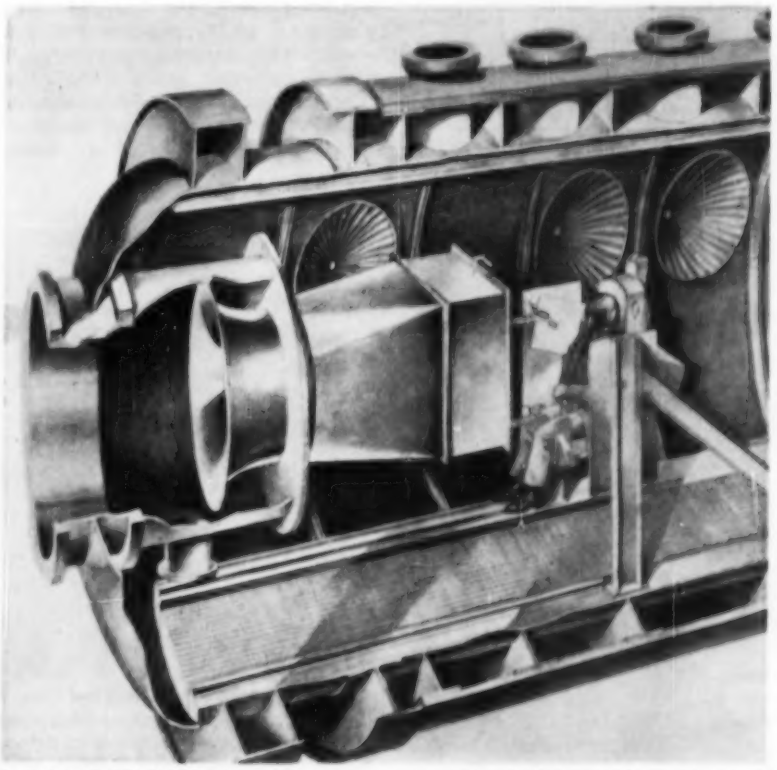
"Filming problems in the case of sled tests made accurate analysis of the behavior of personal flight equipment under actual ejection conditions virtually impossible since minute details of equipment failure could not be seen. The ejected dummies struck the ground with such force that equipment which held up under test conditions was destroyed on ground contact.

"Testing a fully-clothed anthropometric dummy in an air-breathing engine test facility (wind tunnel) where conditions can be exactly controlled and the results accurately observed and photographed has proven highly successful . . . added advantage is that the inlet valve at the mouth of the test cell can be designed to open and close rapidly to stimulate the almost instantaneous rate of onset and decay with relation to maximum dynamic pressure to simulate very accurately the air blast conditions experienced during actual ejection."

In all, 33 test runs were completed over a nine-day program with wind



ENGINE TEST CELL at AEDC in which anthropometric dummy was subjected to transonic wind blast. Right section of cell can slide back to permit entry of large equipment into cell. Tests may be viewed through side windows and on closed circuit television.



CUTAWAY DRAWING shows how dummy was positioned during wind tunnel tests of personal flight equipment. Special devices provided by Martin include large bell mouth air blast reducer (left) and ejection seat fixture which can be tilted at various angles.

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tunnel velocities ranging from 260 kt. to above Mach 1. Dynamic pressures involved ranged from about 250 psf. to 2,000 psf. Complete photographic recordings of each run were made with both still and motion picture cameras.

Testing area used was a 12¼ ft. diameter, 35 ft. long engine test cell capable of operating at velocities exceeding Mach 1 and compressible flow dynamic pressures of 2,000 psf. Inlet valve was designed to open and close fast enough to simulate onset and decay of air pressures comparable to those experienced during actual ejection.

Martin built a special bell mouth fixture which diverted air stream in the tunnel onto the dummy.

Martin-Supplied Equipment

Some of the equipment used for the tests was supplied by Martin. Among these items were:

- **The 2 x 4 ft. bell mouth** adapter to fit existing tunnel orifice. This gave the largest possible blast area for required Mach number considering the air pressure available at the facility.
- **Ejection seat** hold-down fixture which allowed the test dummy to be held in three positions: 18 deg. ejection attitude; 45 deg. or 65 deg. tilt aft of ejection attitude; −27 deg. or 45 deg. tilt forward of ejection attitude.
- **YP6M-1 ejection** seat.
- **Anthropometric test** dummies which were made to the standard 95th percentile. This means that, out of a given number of actual pilots, 95% would have smaller physical dimensions and would weigh less than the dummies, and 5% would be larger and would weigh more.
- **Portable equipment** for making on-the-spot repairs, such as sewing machines, zippers, hardware and tools.
- **Air pressure probes** for instrumentation of the test cell.

Personnel Present

Among personnel present during the 16 hr. day schedule under which the tests were run were:

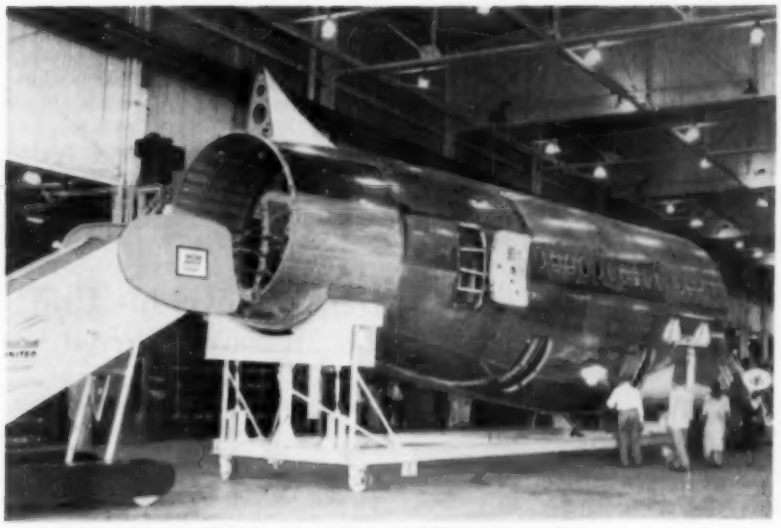
- **Four Arnold Engineering Development Center** plant technicians for each shift of the tests.
- **Group of Martin** personal equipment engineers from the Company's Human Factors Section. Experience of these men comprises over 6,000 flying hours, 270 parachute jumps and over 30 years of working in the areas of design and manufacture of parachutes and personal and survival equipment.
- **Naval personnel** from Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, and from Naval Parachute Unit, El Centro, Calif.

To achieve the closest possible correlation between actual wind blast conditions during actual ejection and the controlled tests, the anthropometric dummies strapped into the ejection seat were equipped with this array of gear: helmet and oxygen mask; flying suit and footwear; parachutes and harness; flotation and survival equipment; full pressure suit; Martin experimental equipment, and such miscellaneous hardware as disconnects and electrical components.

Among the various equipment configurations and combinations tested were:

- **Best Navy** qualified equipment available.

DUMMY (left) is wearing standard Navy summer flying equipment under Navy-designed torso harness which integrates both lap and safety belts and shoulder harness into a common unit. Pulling face curtain down automatically ejects seat and protects pilot's face from wind blast. Dummy (right) is clad in Martin-developed integrated flying equipment which consolidates parachute harness, life preserver and signal flares into flying suit. Oxygen mask is completely encased in a smooth surface retainer to decrease chances of being ripped off by strong wind blast experienced during high speed ejection.



Rohr Builds 707 Section

This 43-foot rear fuselage section of Boeing's 707 jet transport was recently completed on schedule by Rohr Aircraft Corp. under a $13-million contract. Work began Aug. 8. Section is now undergoing pressure tests in a test cell built especially for this purpose. Rohr also builds elevators, stabilizers and jet engine pods for the 707 plus components for Convair's 880 jetliner and Lockheed's Electra turboprop.

• **Martin-designed** integrated personal equipment system.
• **Navy A4D** type equipment.
• **Current Navy** fighter flight equipment tested at average ejection velocities.
• **Navy full** pressure suit.

Test Results

Martin says that "the results of this first in a series of wind tunnel blast cell tests accomplished at Arnold Engineering Development Center indicates that such tests can be considered superior to free ejection testing in certain phases of personal equipment evaluation."

Specifically, the tests led to these conclusions:

• **All equipment** tested at an average ejection speed—260 kt.—was considered satisfactory. However, some failures did occur at dynamic pressures slightly above average.
• **Rates of** onset and decay in a test cell can be made to simulate closely those encountered during actual ejection.
• **Cost of** the nine-day program was but a fraction of the expense of a single sled run.
• **Arm and leg** flailing during wind blast in the test cell and on a free sled ejection is strikingly similar, indicating the feasibility of using test cell runs to work out limb retention problems.
• **Exact dynamic** pressure at which a component fails can be determined by the rate-of-onset vs. time chart, supplemented by test cell instrumentation. Martin says this latter information is extremely difficult to obtain from a free ejection test.

Martin says these were the first successful wind blast tests of a full-size dummy at speeds over Mach 1 conducted in a wind tunnel.

Arnold Engineering Development Center operates as a service to the aircraft industry, educational institutions and government agencies. Overall direction, scheduling, planning and budgeting at the Center is done by a staff of Air Force military and civilian personnel. Facility is operated under contract with Air Research and Development Command by ARO, Inc., a subsidiary of Sverdrup and Parcel, Inc., of St. Louis, Mo.

Laminated Material Withstands 5,000F

New high-temperature material, "Astrolite," has been developed by H. I. Thompson Fibreglas Co., Los Angeles. Astrolite is a reinforced plastic containing laminations of near-pure silica "Refrasil" fibers, in combination with high-temperature phenolic resin binder, affording unusual resistance to temperatures in the 5,000F range for relatively long periods.

Demonstrations using oxy-acetylene flame, gaged by optical pyrometer at approximately 4,600F, applied to half-inch panel of Astrolite showed material to be virtually unscathed after 42 sec. Burn-through did not occur until after 142 sec.

Thompson said that part of Astrolite's short-term thermal resistance is due to its resistance to erosion. Above 3,150F, where Refrasil softens, its viscosity is high enough to prevent it from being easily blown away. Most other refractory materials were said to become quite fluid at these same temperatures. Also, Refrasil vaporizes when it finally is removed. The vaporization tends to cool the surface and contribute to a slower burn-through rate.

Material has been proposed for liners of rocket engines and nozzles, ballistic nose cones and heat shields for critical components.

Plane Air Conditioner Has Gasoline Engine

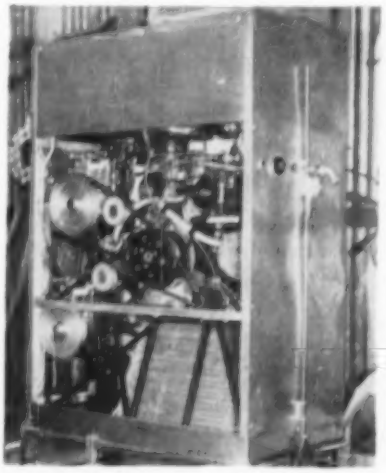
Ft. Worth—Self-contained aircraft air conditioning unit driven by its own gasoline engine has been developed here by Aircraft Industrial Manufacturers, Inc.

Called Aim-Air, the new unit is adaptable to aircraft ranging in size from the DC-3 to the DC-6. It could also be used in radar vans, missile test blockhouses and other enclosures which call for small, high volume air conditioners.

Power for the new air conditioner is a German Zundapp-Werke Model KS 601 two-cylinder engine which develops 26 hp. at 4,000 rpm. Engine drives two freon compressors and two blowers.

Unit's engine runs off the aircraft's fuel supply and burns two gallons per hour. It will handle 87 to 115 octane fuel. Only electrical requirements from the aircraft system are for engine ignition and starting.

Top capacity is 75,000 Btu. per hour, and output is thermostatically controlled. Designers figure that Aim-Air can bring a cabin ambient temperature of 130 F down to 80 F within 10 min. Using fresh air input at 100 F, system delivers 900 cu. ft. of air per minute



AIM-AIR aircraft air conditioning unit is driven by a German-made two-cylinder engine which runs off aircraft's fuel supply.

Condensed Fire-Fighting Package

Old and new airborne fire-fighting packages have been developed to be slung as external cargo from Kaman HOK-1 helicopters. Original unit is at left; new, condensed version at right. Original package was assembled by Kaman from available Ansul equipment. Unit on the right was specially designed and built by Ansul for Kaman. Original unit weighs 1,530 lb., new unit 628 lb.; length was pared from 7 ft. 1 in. to 3 ft. 10 in. New unit's dry chemical capacity is reduced 200 lb.—from 600 lb. to 400 lb.; expelling agent is cut in half, from 220 cu./ft. of nitrogen to 110 cu./ft., and hose lines are changed to two lightweight neoprene lines with dual stream nozzles instead of two standard lines with dual stream nozzles as used on original package. Hose lines are slung on two arms extending in front of original package and on white tubular supports attached to sphere of new unit. Kaman was recently awarded an Air Force contract for the production of H-43A and H-43B local crash-rescue helicopters.

at 39F within a minute and a half after starting.

In the unit, one blower draws cooling air through the condensers and across the compressors and engine, then exhausts it. Other blower supplies forced air across the direct expansion coils and through cabin air ducting for circulation and expansion.

Unit is contained in a 35 x 19 x 50 in. stainless steel cabinet which is integrally braced and lined with Fiberglas. Ann-Air itself weighs 358 lb. With freon and ducting, installed weight is less than 400 lb. Price is $7,500 f.o.b. Ft. Worth.

Edison fire detectors are used for fire warning, and a single control allows the pilot to close the air intake damper and cut engine ignition and fuel supply before shooting CO_2 into the cabinet.

If the aircraft uses an auxiliary power unit, it can be replaced by a 28 v. d.c. generator integrated into system.

Producer Should Know Military Requirements

New York—Accelerating pace of technology makes it more important than ever that manufacturing firms keep abreast of military requirements, J. Lewis Powell, Office of the Assistant Secretary of Defense, Supply and Logistics, told a recent meeting of the Drop Forging Assn. here.

Powell urged firms interested in defense work to remain in contact with their Armed Services Procurement Planning Officer to see that they were either correctly listed in the official Register of Planned Mobilization Producers or should be added to the 21,000 plants included. This was particularly true for those firms which manufacture hard-to-get, hard-to-make, direct military items, Powell said.

He added that in the next war there would be no chance to mobilize and that U. S. defense must be like a fire department, ready and equipped to be able to put out any sort of fire.

Trainer Will Simulate Convair 880 Cockpit

Cockpit procedure trainer for Convair's 880 jet transport will be built by Burton Rodgers-Technical Training Aids, Inc. under a $1 million contract.

Trainer will incorporate full instrumentation for pilot, copilot and flight engineer. It will simulate operation of the plane's jet engines and its hydraulic, electrical, cabin pressurization and anti-icing systems.

In a new move for Burton Rodgers, electronic computers will be used to make instruments simulate actual in-flight conditions. Heretofore, the company steered away from computers, or used relatively straightforward mechanical devices to simulate in-flight conditions. Trainer will be used to teach 880 operation to pilots and ground crews of airlines buying the aircraft.

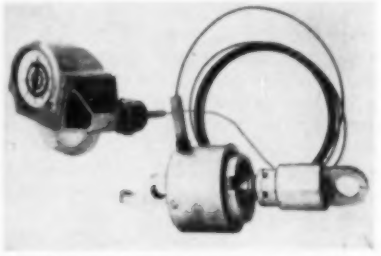
Delivery of the trainer will coincide with factory completion of the first 880 in November, 1958.

BOAC Develops Unit To Measure Thrust

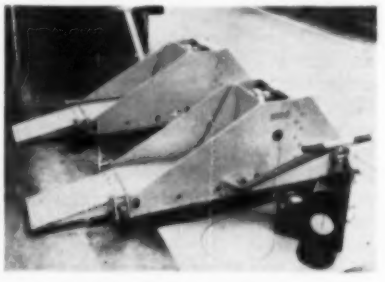
Portable ground thrust platforms which enable aircraft thrust to be measured accurately to ±0.3% directly through the undercarriage have been developed by BOAC engineers at London Airport. An airborne version based on the same principles has been extensively tried on some military jet aircraft. Significant deviations from the computed thrust ratings have been recorded.

The thrust meter, which consists of a hydrostatic load cell communicating pressure changes to a bourdon tube and gage, is that used extensively in aircraft weighing installations. A glycerine-based fluid, isolated in a cylinder by a neoprene diaphragm, is loaded by a ram which communicates the thrust. Changes in fluid pressure deflect the bourdon tube in a near-linear manner and give a direct reading of engine thrust. Absence of an external power supply, its ability to hold calibration, great accuracy, and neglible temperature effects over a useful working range are among advantages endowed by the hydro-static load cell principle.

The cell has an accuracy of ±5 lb. in



THRUST meter is above. Each platform (below) can accept to 14,000 lb. thrust.



14,000 lb. and readings taken at points of increasing and decreasing thrust show no hysteresis.

The two platforms onto which the aircraft is wheeled are designed for single-wheeled aircraft with a leg load of up to 40,000 lb. Each is capable of accepting up to 14,000 lb. thrust. Larger units can go up to one-million pounds thrust capacity.

The load cell can be located in the platform to permit alignment with aircraft axle height, the platform itself being placed against an abutment.

Remote reading of the cell can be arranged through flexible capillary and detachable capillary couplings. The total thrust of any engine is the sum of the thrust readings from each platform.

In the airborne application the load cell is located in the engine trunnion mounting and is connected to a meter in the cockpit by a flexible capillary. Total weight of a single engine installation is only 8¼ lb. Meter has a three-fingered dial giving a ½ in. deflection for 5 lb. load increments.

Ram and cylinder are made from a high nickel alloy having a low temperature expansion coefficient which makes the cell temperature independent over a useful working range.

WHAT'S NEW

Publications Received:

Buildings For Industry—by the editors of Architectural Record—Pub. F. W. Dodge Corp., 119 West 40th Street, New York 18, N. Y. $9.75; 390pp.

A study of contemporary industrial architecture and its problems. The book should be of interest to architects, engineers, contractors and industrial executives.

A History of the United States Air Force 1907-1957—by Alfred Goldberg—Pub. D. Van Nostrand Co., Inc., 120 Alexander Street, Princeton, N. J., $6.75; 288pp.

This book tells in words and pictures the story of 50 years of military aviation in the United States, and how it has developed into a force for the maintenance of national security and world peace.

The Ford Story—by William T. Larkins—Pub. The Robert R. Longo Co., Inc., 1318 Beaumont Drive, Wichita 4, Kans. $4.95; 178pp.

A pictorial history of the Ford Tri-Motor 1927-1957.

Closed Circuit TV System Planning—by Morris A. Mayers and Rodney D. Chipp, P. E.—Pub. John F. Rider Publisher, Inc., 116 West 14th Street, New York 11, New York. $10.00; 264pp.

This book is the most complete and authoritative advisory source for all who are contemplating the use of closed circuit television. An excellent guide for those who are faced with the responsibility of planning and evaluating closed circuit TV systems.

Investment Casting Engineering and Design Manual—Pub. Investment Casting Institute, 27 East Monroe Street, Chicago 3, Ill. $5.00; 50pp.

This manual has been designed to aid industry to more clearly understand the advantages and limitations of the investment casting process, and should be of great value to the design engineer, metallurgist and purchasing man.

Rocket—by Air Chief Marshal Sir Philip Joubert de la Ferte—Pub. New York Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. $6.00; 190pp.

This book, a historical account of rocket evolution, tells how rockets were considered both in the East and West as potential weapons of war.

Principles of Electrical Measurements—by H. Buckingham M. Sc., Ph. D.—Pub. New York Philosophical Library, 15 East 40th Street, New York 16, N. Y. $15.00; 600 pp.

The chief aim of this book is to provide a knowledge of the principles employed in making electrical measurements and to explain the methods of applying these principles.

Aircraft Annual—edited by John W. R. Taylor—Pub. The New York Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. $6.00; 96pp.

Information on the advance of the air age is given in this book, which comprises a series of articles illustrated with photographs.

Chase Pilot Wears Helmet Camera

Convair-Ft. Worth pilot George Davis is wearing a helmet camera that enables him to pay closer attention to the controls of his TF-102A when he flies chase during B-58 test flights. Pilot sights through eyepiece in front of his right eye (below), presses button on flight controls to operate camera.

PRODUCTION BRIEFING

Society for the Plastics Industry, Inc., said that the poundage of reinforced plastics in aircraft and missile is expected to go down from 28 million lb. in 1956 to an estimated 25,200,000 lb. in 1957. The 1957 figure is expected to be 15% of the total reinforced plastics used by all phases of industry.

However, the Society expects that the development of high-heat-resistant plastics used for short heating durations in missiles will increase. It predicts that these new materials will make up as much as 85% of the airframe weight of future missiles.

Use of plastics in missiles and jets as a heat shield for metals illustrates the extreme requirements these materials can meet, according to the Society. Research now in progress is subjecting improved reinforced plastics to temperatures as high as 14,500 F, a temperature that instantly vaporizes all known materials.

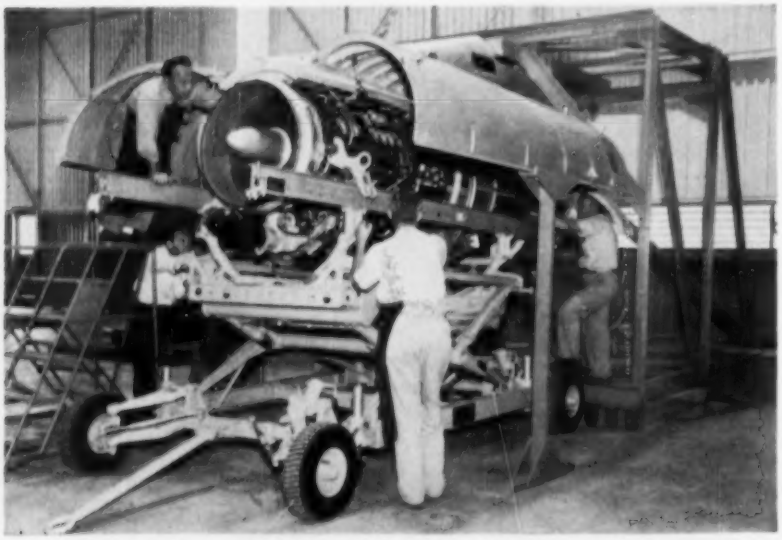
Another development with missile potential is the refinement of production line techniques which will eliminate much hand work in fabrication.

Vacuum degassing of steel can be done economically, K. C. Taylor, specialist from F. J. Stokes Corp., Philadelphia, Pa., told the Second International Metallurgical Congress which met recently at Chicago. Taylor said that vacuum stream degassing costs only a moderate amount more than conventional steelmaking methods.

While vacuum stream degassing, Taylor said, up to 250 lb. of molten metal tapped from the open-hearth or electric furnace has been carried to the vacuum chamber either in a single ladle or by a series of ladles. The sudden pressure drop as the stream of hot metal entered the vacuum chamber caused the molten metal to burst into a fine spray as it fell into the chamber. The effect of the vacuum on the stream was said to be tremendous. The narrow stream coming out of the ladle is torn apart by the gas being released from the metal and the spray may expand to a width of as much as several feet. The falling metal globules are irregular in form. This diffusion of the metal into many small particles, Taylor said, exposes a large amount of surface area to the effect of the vacuum and results in the elimination of the majority of the gases that are contained in normal metal.

Premium for vacuum refining by this method is only 1 cent per pound as against 20 cents per pound for consumable-electrode melting and 40 cents per pound for induction melting.

Technical manuals on the Atlas, Titan and Thor will comprise the largest single technical manual program ever undertaken, D. R. McDowell, manager, Technical Services, Guided Missile Research Division, Ramo-Wooldridge Corp., Los



Technique Claims 30-Min. Engine Change

Engine-handling techniques and cart have been developed at Convair's San Diego plant to permit 30-min. engine changes of General Electric CJ-805-3 turbojets which will power Convair's four-engine 880 jetliner. Procedure involves hand unfastening of 18 latches to open pod's clamshell doors, removing one bolt, loosening two more, removing two trunnions, disconnecting four clamps and five tubes and disconnecting six electrical plugs. First flight tests of the 880 are scheduled for January, 1959.

Long Range Planning and Research at Marquardt...

by
Roy E. Marquardt
President

Although ramjet development in the Powerplants Division is the major activity here at Marquardt, there are three other divisions carrying on significant work; Controls and Accessories, Test, and Long Range Planning and Research.

The youngest of these Divisions is Long Range Planning and Research. Headed by John Drake, and numbering 50 engineers, the Division has two primary functions:

PLANNING — anticipating product trends in areas where we now operate or might enter. Actually this planning is done in a staff capacity, and normally the results end up as recommendations.

SUPPORT — to the other divisions, by introducing product improvements which offer promise for the future. These improvements generally involve a small scale program to establish the idea as feasible. This research function also may be concerned with areas which do not fit into present Marquardt projects.

Long Range Planning and Research was begun in 1954. One of its first studies concerned areas where the ramjet can now be used or where it might be used in the foreseeable future. To date some exciting new powerplant cycles have been plotted. Some are variations of cycles now in existence, others are radically different.

Projects also have probed new "exotic" fuels, new types of diffusers, accessory systems, and controls. One phase of Aircraft Nuclear Propulsion is now being explored.

Ground was broken near Newhall, California recently for a research test center. This aerodynamic facility will have testing capabilities to Mach 14.5 as a wind tunnel and Mach 10 for free jet testing with excellent simulation of full scale flight conditions (Reynolds Number). In addition, it will permit simulation of combustion conditions to Mach 8 and altitudes above 150,000 feet.

Within this Division, research engineers will find a spectrum of research engineering opportunities, including:

DESIGN	AERO-THERMODYNAMICS
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CONTROLS	COMBUSTION

For information about these positions and the professional engineering environment at Marquardt, we invite you to write Jim Dale, Professional Personnel, today.

Roy E Marquardt

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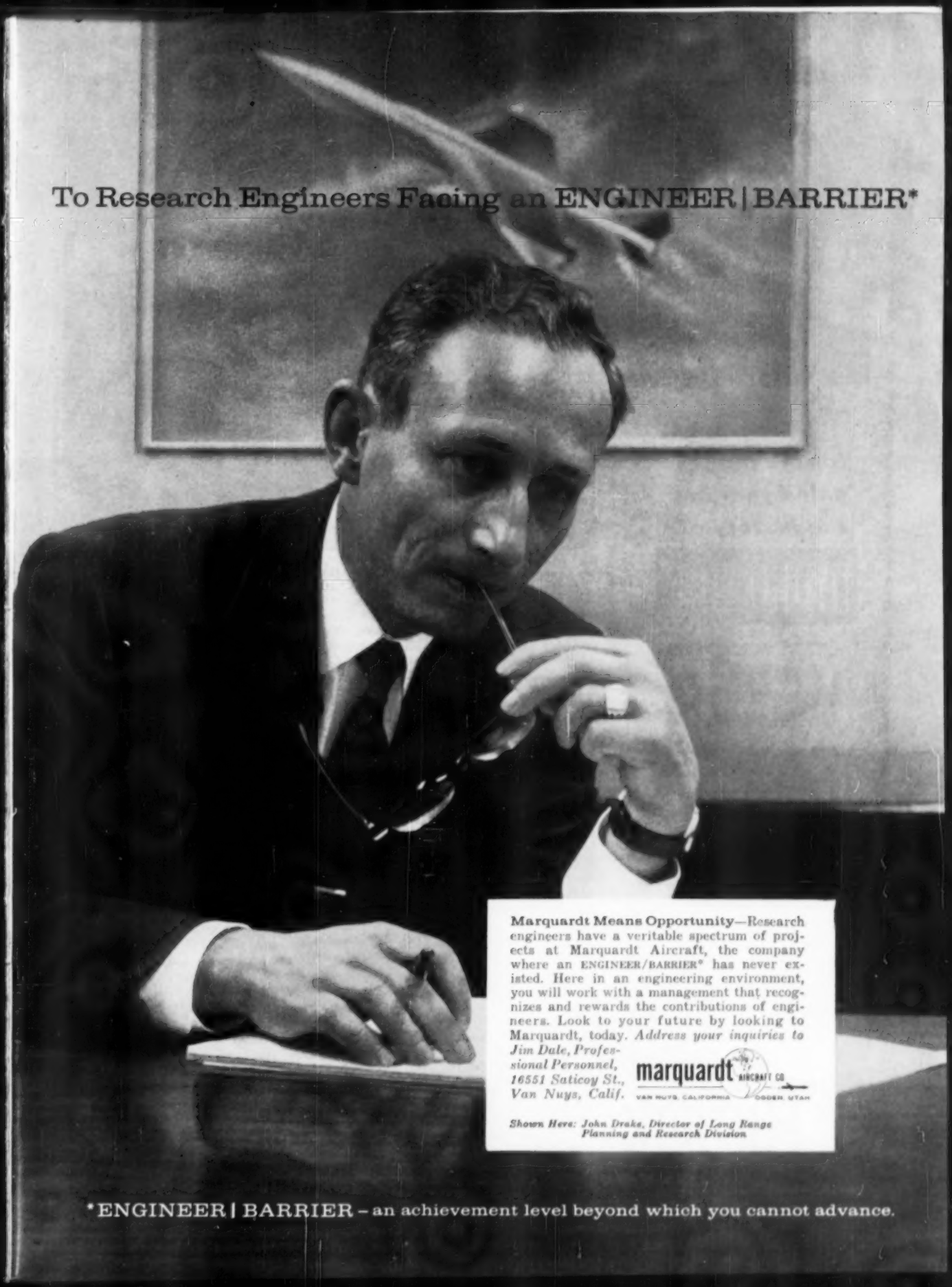
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Photographic C-130

This is the first of 15 photographic versions of the C-130 Hercules turboprop-powered cargo plane that Lockheed Aircraft Corp.'s Georgia Division will produce for the 1370th Air Photographic and Charting Service, Palm Beach AFB, Fla. Air Force cameramen and map makers from the 1370th will soon take familiarization flights in the prototype plane. First production RC-130s will be delivered to USAF beginning in January, 1958. Inset shows cameraman at work.

Angeles, told a session on "Standardization for Technical Communication" at the Eighth National Conference on Standards, San Francisco. Special attention will be paid to aiming the manuals at the personnel who will use them and making them timely with regard to missile modifications. The manuals will be of a size which will fit into standard USAF coverall pockets. Design changes will be teletyped directly from the contractor's plant to the operating base where the change will be printed on multilith plates.

Fairey Aviation Co., Ltd., has become a full member of Atomic Power Constructions Ltd., to further the company's atomic interests.

Temco Aircraft Corp., Dallas, Tex., has received a new contract exceeding $25 million for production of 58-ft. aft fuselage sections for the improved B-52, the B-52G.

Latrobe Steel Co. said that its new plant at Latrobe, Pa., provides the first large rolling mill devoted to rolling superalloys for jet aircraft and missiles. Latrobe said that fine highspeed steels and difficult-to-work superalloys require special techniques such as diamond-grooved rolls which "knead" superior internal grain structure into the superalloys. The mill can handle 18 in. sq., 4,000 lb. ingots. It can produce billets from 3 in. sq. to slabs 12 in. wide.

Production tooling for Bristol Aircraft Ltd. helicopters types 173 and 192 includes shaped jig portions made of Bakelite paper-based laminate. Type 192 is to be powered by two Napier Gazelle free-turbine engines.

Reaction Motors, Inc., Denville, N. J., said that it is acquiring over 28 acres of land in the Lake Denmark area to provide for future expansion of its rocket test facilities. Adjacent to the site of the company's new million-lb. thrust all-attitude test stand, the additional acreage will also serve to isolate work on large engines such as the powerplant for the X-15 high altitude research vehicle. Reaction Motors also announced receipt of a subcontract for development and delivery of a limited number of liquid propellant engines for Radioplane Division of Northrop's RP-76A target drone. The subcontract will include both booster and sustainer units.

CAB Accident Investigation Report:

Bearing Failure Preceded Propeller Loss

American Airlines Flight 87 of March 5, 1957, a Douglas DC-7, N 316AA, lost the nose section and propeller of its No. 1 powerplant while in flight near Memphis, Tenn., on March 5, 1957, about 1127.[1] Parts struck and pierced the pressurized fuselage causing explosive decompression. Flying debris within the cabin and the abrupt pressure change resulted in several personal injuries. The aircraft was landed at the Memphis Airport about seven minutes later without further difficulty.

HISTORY OF THE FLIGHT

Flight 87 originated at New York International Airport (Idlewild) for San Francisco, with one stop scheduled at Dallas, Tex. There were 41 passengers with a crew of Capt. Leroy T. Hansard, First Officer Adrian B. Cummins, Flight Engineer Leonard C. Bowers and Stewardesses Barbara Kearney and Mary Marsh. The aircraft's gross weight was less than the allowable maximum and its center of gravity was located within prescribed limits.

Departure from Idlewild was at 0815 on an IFR flight plan. Routine position reports were made over Charleston, W. Va.; Nashville, Tenn.; and Graham, Tenn. At 1106 Air Route Traffic Control cleared the flight, then at 12,000 ft., to climb to and maintain 14,000 ft. At 1113 the flight reported over Jackson, Tenn., at 14,000 ft.

About 1127 the captain noticed vibration in the cowling of No. 1 engine. He started checking engine instruments and told the flight engineer to use the ignition analyzer.

Vibration increased; the captain quickly decided to feather the engine and started closing No. 1 throttle. When it was halfway back engine speed rose to about 3,300 rpm., whereupon he closed all throttles, disengaged the autopilot and nosed the aircraft up to lose speed. Engine speed of No. 1 continued to rise to an estimated 4,300 rpm. and as the captain was using the toggle switch to reduce this rpm, the propeller and nose section separated from the engine.

The rotating propeller struck the top of the fuselage, causing a large area to blow out. This was 20 to 25 sec. after the vibration was first noticed.

Just about that moment the flight engineer had pressed the No. 1 feathering button and pulled the No. 1 mixture control to idle cutoff.

Descent Made

Capt. Hansard told his first officer to report an emergency; descent and landing clearance at Memphis was quickly coordinated by company radio, ARTC and the tower. Descent was started at a rate of about 2,000 fpm. with airspeed about 200 kt.

The aircraft came below clouds and into weather conditions allowing visual flight at an altitude of 2,500 ft. when some four miles southeast of the Memphis Airport. An uneventful landing was made on runway 27 at 1134 in light rain with three miles visibility while previously alerted but unneeded emergency apparatus stood by.

All occupants were examined by a physician the same day.

All passengers and crew members were found to be affected by the sudden decompression; five of the passengers had received contusions, lacerations and abrasions from fuselage parts and debris.

INVESTIGATION

At the time of the failure and blowout the aircraft was pressurized 5.1 pounds per square inch above the external pressure. This pressure differential caused a violent outrush of air greatly enlarging the initial rents into a jagged, and irregular, large hole, approximately 17 ft. long by 4 ft. laterally, in the forward cabin roof and tearing off and hurling both lavatory doors and the cabin flight deck door about the cabin. Numerous unsecured articles, blankets, pillows, personal effects, etc., were also thrown about. There was considerable deformation and bulging of panels and bulkheads and damage of other nature which, although widespread, did not significantly impair control.

When the captain told the first officer to report an emergency the latter called the company saying that they were declaring an emergency and were going to make an emergency descent to land at Memphis. The company immediately coordinated with ARTC and all aircraft under approach control jurisdiction were provided radar separation from American 87. The first officer declutched both cabin superchargers, called out the altitude of 12,500 msl., and tuned his omni receiver to Dyersburg to get a cross check on position. The flight was between Williston and Fisherville, according to this check. He changed over to the tower frequency and was advised that all runways were available. The captain said he would land straight in on runway 27. The first officer tuned his ADF to the Memphis middle marker and advised the captain accordingly. The flight broke out contact and the captain called for landing gear down. Shortly he called for 30 deg. flaps, then full flaps. The first officer called out altitude and airspeed.

Inspection of the No. 1 powerplant showed that the propeller and most of the nosecase assembly had torn away just forward of the front cam gear train assembly. The front oil sump remained in place attached by its external oil lines. The left distributor and the propeller governor pad were intact on a section of the front nosecase; all other portions of the engine's front section were missing. The forward 18 in. of the antidrag cowling was cut off flush with the front row of cylinders by the spinning propeller; the remaining portion of the cowling assembly remained on the engine. After this initial contact the propeller struck the fuselage in three distinct places.

The aircraft control systems and surfaces were undamaged. Slight damage to the leading edge and underside of the left wing was caused by contact with turbine blades which failed and were slung off by the over-speeding No. 2 power recovery turbine of No. 1 engine.

Nos. 1 and 2 blades of the No. 2 propeller were gouged deeply on their face (back) surfaces by thrown parts although the operation of this powerplant was unaffected. Nos. 3 and 4 powerplants were undamaged.

Numerous pieces of all four blades of No. 1 propeller were recovered after tedious ground search. The outboard 23 in. of three blades and 40 in. of the fourth were not found. Parts of the blade which had its outer 40 in. missing were found in the engine nosecase cavity and cylinder assemblies. All fractured sections of all blades exhibited impact failures, but no fatigue cracks.

There were four distinct cuts made by the spinning propeller. These followed a pattern from left to right and to the rear. The first was in the engine antidrag cowling 23 in. aft of the plane of rotation of the propeller and in line with fuselage station 281; the other three were quite evenly spaced at stations 394, 421 and 460. A study of the service history of this model propeller and model engine combination to date has failed to reveal any evidence of in-service blade failures.

No Fire Evident

No. 1 engine was thoroughly inspected for evidence of inflight fire; none was found. The crew stated that during the emergency they received no fire warning and did not observe any in-flight fire.

All of the major components of the front crankcase assembly were recovered with the exception of the roller thrust bearing, a section of the hollow propeller shaft and part of the nosecase. Examination of the recovered parts revealed excessive operating temperatures of the propeller shaft where the ball and roller thrust bearings are seated. The shaft, which had failed aft of the roller bearing journal, was blackened by heat and was necked down under high tensile loading on one side. On the opposite side of the shaft and wall thickness had been increased due to high compression loads. The propeller shaft flange had a circumferential shear overload fracture which had detached the flange from the shaft with metal ad-

[1]All times herein are central standard and based on the 24 hr. clock.

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When it comes to end products, Bill Crowder never finishes what he starts.

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jacent to the fracture deformed forward. The shaft flange also was blued due to excessive temperatures. All fractured surfaces of the propeller shaft sections were of the overload type of failure; none of these fractures showed any evidence of fatigue.

The ball thrust bearing was severely damaged by overheating. Its inner and outer races were scuffed and flattened, and contained metal deposits from the melted bronze bearing retainer. All balls were in place but were flattened and blackened by overheating. The operating temperature of this bearing had reached a point high enough to melt the bronze ball retainer as well as to weld the inner races together. Destruction of the ball thrust bearing was so extensive that the possible presence of fatigue could not be learned.

The fit of these bearings at the time of engine assembly is very critical. Engine overhaul records reflect that these components were built up according to the manufacturer's recommended procedures. The last engine overhaul was 346 hr. prior to the accident. At that time the ball thrust bearing used was a serviceable unit and the roller thrust bearing was new. The engine itself had a total service time of 6,609 hr. which embraced 10 overhauls. The ball thrust bearing had been inspected, reworked as necessary, and reinstalled following these overhauls.

Crankcase Examined

The crankcase front flange and seal assembly was thoroughly examined as a possible source of primary failure. If this assembly had failed first, it would allow bearing lubricating oil to be lost resulting in oil starvation to the propeller thrust bearings. Examination of the front flange and seal assembly revealed it to be dished rearward and enlarged so that its inner diameter was approximately one inch more than normal. The bearing liner flange was cracked at each cap screw position and did not exhibit any indications of overheating. The front flange assembly cap screw bushings had pulled out of the case and several bushings had filled with molten magnesium. The bearing liner flange fractures were circumferential and radial in nature due to overloading with no evidence of fatigue. This bearing liner was also free of indications of high operating temperatures, apparent in other sections of the nosecase. Enlargement of the inner diameter of the front flange assembly probably occurred just prior to and with the propeller shaft failure due to the entire propeller assembly rotating off center after failure of the thrust bearings.

Numerous metal particles were found in the front oil sump and the front pressure and scavenger oil pumps. The rear sump and oil pumps had similar metal particles but in much less quantity. Metallurgical examination of these particles revealed them to be from the thrust bearing balls or rollers, the ball retainers and bearing surface plating.

In order to determine whether any other failure may have caused the loss of the propeller and front nosecase assembly, the entire engine was disassembled. This examination revealed no conditions which could have caused the subject failure.

The power recovery turbines had thrown some of their blades during the overspeeding of the engine. Their speed at an engine speed of 4,000 rpm. would have been 26,000 rpm. They are designed to fail at approximately 24,000 rpm. because failure at greater speed could endanger the integrity of other parts of the aircraft.

Bell HUL-1 Simulates Rescue in Turkey

Navy Bell HUL-1 performs a simulated rescue in the harbor at Izmir, Turkey. During shipboard evaluation by Helicopter Utility Squadron 2, Detachment 76, craft was flown almost 100 hr. in one month, carried more than 20,000 lb. of cargo and about 250 passengers in all types of weather.

Examination of the flight logs and flight engineer's log indicated that the subject powerplant had been operating normally. There were no pilot complaints and the flight engineer's log showed that all engine pressures and temperatures were within normal operating limits. Overhaul records indicated that the powerplant had been properly overhauled according to the manufacturer's specifications. At the time of the trouble the engines were operating, according to the crew, under the following conditions: All at 2,400 rpm.; all having fuel flow at 740-750 pounds per hour; all in low blower at 35 to 35½ in. of manifold pressure and drawing 170, 180, 168, and 170 lb. BMEP, for Nos. 1, 2, 3 and 4, respectively. These conditions were within operating limits set by the manufacturer and practiced by the carrier.

Prior to the accident, the ball bearing was installed ahead of the roller bearing. This was done to reduce the radial load on the roller bearing. As a result of this accident the manufacturer issued service bulletins for the improvement of the inspection of the propeller thrust bearings and for the interchanging of the position of these bearings. The CAA has issued Airworthiness Directive 57-6-4 which covers the same items.

ANALYSIS

Of all the possible causes of losing the propeller and engine nose section the two most likely were either a failure of one of the propeller thrust bearings or a fatigue failure of a section of a propeller blade.

Because the outer sections of the propeller blades were not recovered, the possibility of a fatigue failure in one of these missing sections cannot be entirely disproved. In analyzing this possibility the Board concludes that there was not a blade failure due to fatigue. This belief is supported by the following reasons. First, when a blade fails due to fatigue or other reasons, the unbalanced condition generally results in severe vibration before propeller tears free.

No Severe Vibration

In this case there was no severe vibration; the only vibration was a slight visible shaking of the engine cowling which was not transmitted to the structure and was not sensed on the controls. Second, when a blade failure is the initial occurrence the entire engine is apt to be wrenched violently and quickly from the firewall or its ring mount. In this accident the engine came apart just forward of the mating surface of the front crankcase section indicating that there were no large unbalanced centrifugal forces. Also, the propeller shaft was extremely overheated, stretched, and necked down in the vicinity of the fracture.

If a blade had failed as a result of fatigue this extensive overheating and softening of the propeller shaft would not have had time to materialize in the short interval of 20 to 25 seconds between the first vibration and the loss of the propeller assembly. Also, the four rather evenly spaced cuts made by the propeller were quite obviously made by the four blades while still attached to

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their hub. Past propeller blade failures have not resulted in this pattern of damage. The difference in the length of the missing blade tip (3 of 23 in., 1 of 40 in.) could have resulted from the longer portion being broken off when that blade struck the speed ring and engine.

Temperatures Localized

The second possibility remains and is strongly indicated as the reason for the loss of the propeller and nose section. Extreme temperatures were localized on the thrust bearing journals of the propeller shaft and separation of the propeller shaft occurred due to excessive overloading in the area aft of the centerline of the roller thrust bearing. Examination of the crankcase front flange and seal assembly indicated that its failure did not precipitate the sequence of other failures.

As to the cause of the probable failure to the thrust bearings several possibilities exist: Lack of lubrication; improper bearing fit at time of engine overhaul; improper bearing inspection relative to ball to race, or roller to race, clearance; or manufacturing defects.

Of these possibilities there is very little concrete evidence available to support any one possibility over others.

The first oil jet in the engine which directs oil to the thrust bearings was in good condition as were other nose section components. It is most likely that the oil supply to the bearings was adequate since these bearings had operated 346 hr. The specific cause of the thrust bearing assembly failure cannot be determined due to the nonrecovery of the roller bearing and the extreme damage to the ball bearing.

FINDINGS

On the basis of all available evidence the Board finds that:

1. The air carrier, the aircraft and the crew were properly certificated.
2. The aircraft's weight and center of gravity were within the prescribed limits.
3. A thrust bearing in the nose section of No. 1 engine failed without warning.
4. This failure occurred during level cruis-

ing flight with stabilized engine operation.

5. The failure set off a train of other failures culminating in loss of No. 1 propeller and engine nose section.

6. Propeller blades pierced the pressurized cabin at stations 394, 421, and 460, causing explosive decompression creating a hole approximately 17 ft. by 4 ft.

7. Control was retained and the aircraft was landed without untoward difficulty.

PROBABLE CAUSE

The Board determines that the probable cause of this accident was failure of the propeller thrust bearing assembly, which resulted in separation of the propeller and subsequent penetration of the fuselage causing explosive decompression of the aircraft in flight.

By the Civil Aeronautics Board:

James R. Durfee
Chan Gurney
Harmar D. Denny
Louis J. Hector

Member G. Joseph Minetti did not take part in the adoption of this report.

SUPPLEMENTAL DATA

Investigation

The Civil Aeronautics Board was notified of the accident immediately after occurrence. Investigation was started immediately in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended.

Air Carrier

American Airlines, Inc., is a Delaware corporation with general offices in New York City. It operates as an air carrier under currently effective certificates of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration. These certificates authorize the company to transport by air persons and property over many routes within the continental limits of the United States, including the route being flown in this instance.

Flight Personnel

Capt. Leroy T. Hansard, age 43, was properly certificated for the subject flight. He had been employed by American Airlines for more than 15 years. His flying time was in excess of 17,000 hr., of which 2,380 hr. had been in DC-7s. His required periodic examinations and checks were current.

First Officer Adrian B. Crimmins, age 35, was also properly certificated for the subject flight. He had flown a total of 5,480 hr., of which 17 had been in DC-7s. All of his required periodic examinations and checks were also current.

Flight Engineer Leonard C. Bowers, age 36, held a current flight engineer certificate. His total experience was some 4,800 hr., of which only 3 hr. 34 min. had been in DC-7s.

Both stewardesses, Miss Mary Marsh and Miss Barbara Kearney, had satisfactorily met all company requirements in regard to emergency training and procedures.

The aircraft, a Douglas DC-7, serial number 44137, had been acquired new by American Airlines in February, 1954. Since that time it had been flown 8,803 hr. The last periodic maintenance check was a No. 17 check performed on Feb. 26, 1957; at that time the aircraft had accumulated 8,732 hr. The aircraft had received a service check the day before this accident.

The engines were Wright model 972TC-18DA-2. The subject engine, No. 1, serial number 548235, had had a total of 6,609 hr., of which 346 had been since its last overhaul.

The propellers were Hamilton Standard model 34E60, blade model 6921C-8. The subject propeller hub, No. 1, was serial number 179953. The four blades were serial numbers 597614, 15, 16 and 17. The hub had had 8,548 hr. total time and all four blades had had 5,973 hr. total time. Time since overhaul of hub and all four blades was 2,035 hr.

Curtis, Tryon Receive Flight Safety Awards

Palo Alto, Calif.—Flight Safety Foundation awards for distinguished service in achieving safer utilization of aircraft were presented recently on behalf of Aviation Week to Edward P. Curtis, vice president of Eastman Kodak, and George H. Tryon III, secretary of the Aviation Committee for the National Fire Protection Assn.

Curtis received the award in recognition of a report which he prepared upon request of President Eisenhower on "Aviation Facilities Planning" which included "A Plan for Modernization of the National System of Aviation Facilities."

The report embraces the modernization of the nation's system of aviation facilities over the next two decades and covers all aspects of mutual safety problems involved in air traffic control, military, civil, instrument and contact. Curtis is a major general in the USAF reserve.

Tryon's award was accompanied by a citation which read in part: "His courage and persistence in the face of difficulties that appeared insurmountable in the early days of his efforts have resulted in many fire prevention and fighting practices now widely accepted by the aviation industry. These include methods for rescue and fire fighting, fueling equipment and methods, and the dissemination of information on all phases of aviation fire problems."

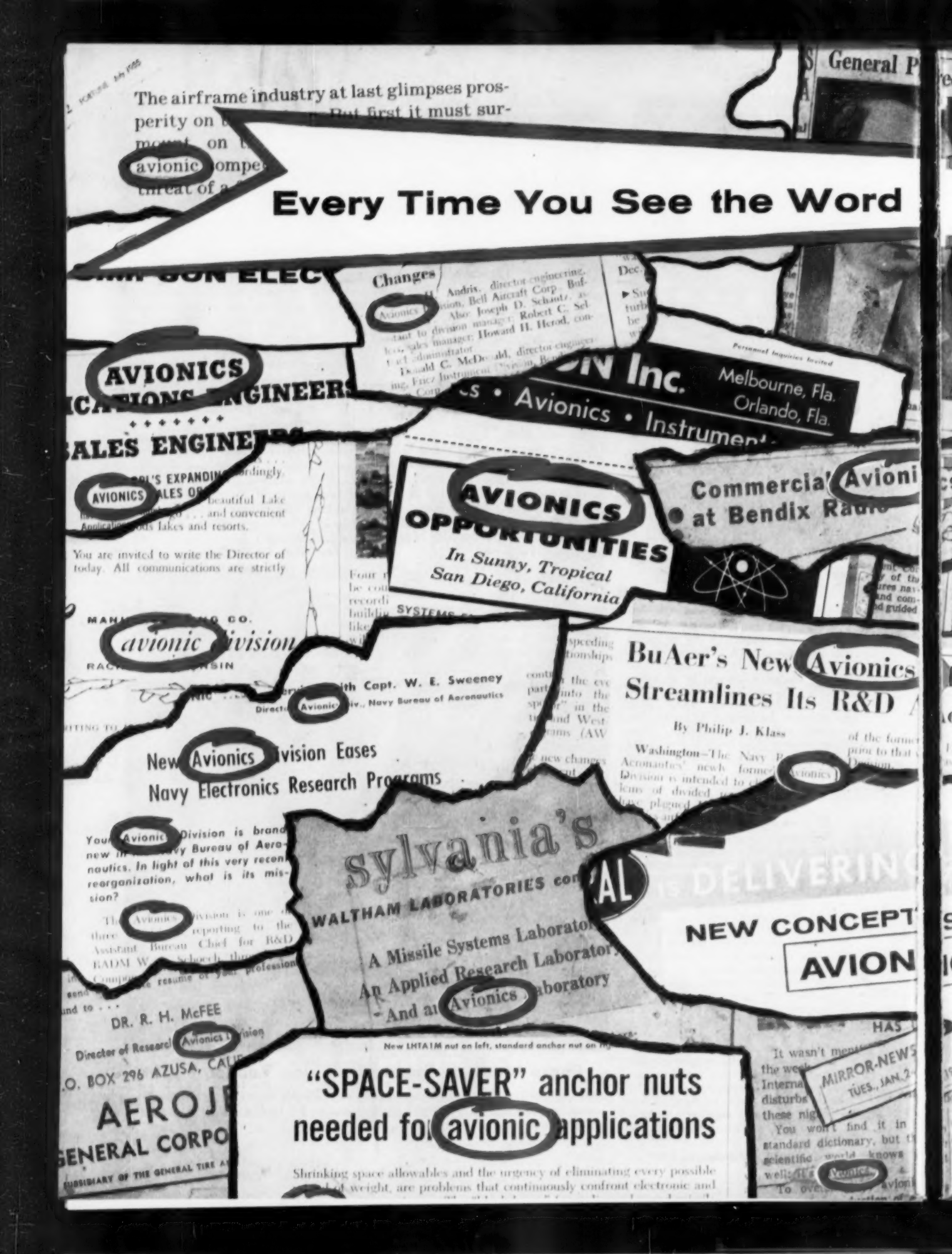
Jerome Lederer, managing director of the Flight Safety Foundation, presented the awards.

Civil Aeronautics Administration Santa Barbara airways operations specialists Max W. Landis and Raymond G. Chase received Flight Safety Foundation awards of merit for their quick thinking and close attention to duty, which probably prevented an air accident.

The pilot of a small plane, using an approach chart with fine print and a red flashlight to augment poor cockpit lighting, read the wrong line on the chart. He probably would have crashed his plane into a mountain if the error had not been discovered by Landis and Chase.

Photo Made on Record-Breaking Voodoo Flight

Photograph of Danville, Ill., was taken at 1200 EST, altitude 45,000 ft., on record-breaking mid-air refueling flight of four Tactical Air Command RF-101C Voodoos (AW Dec. 9, p. 34). Photo was made at supersonic speed.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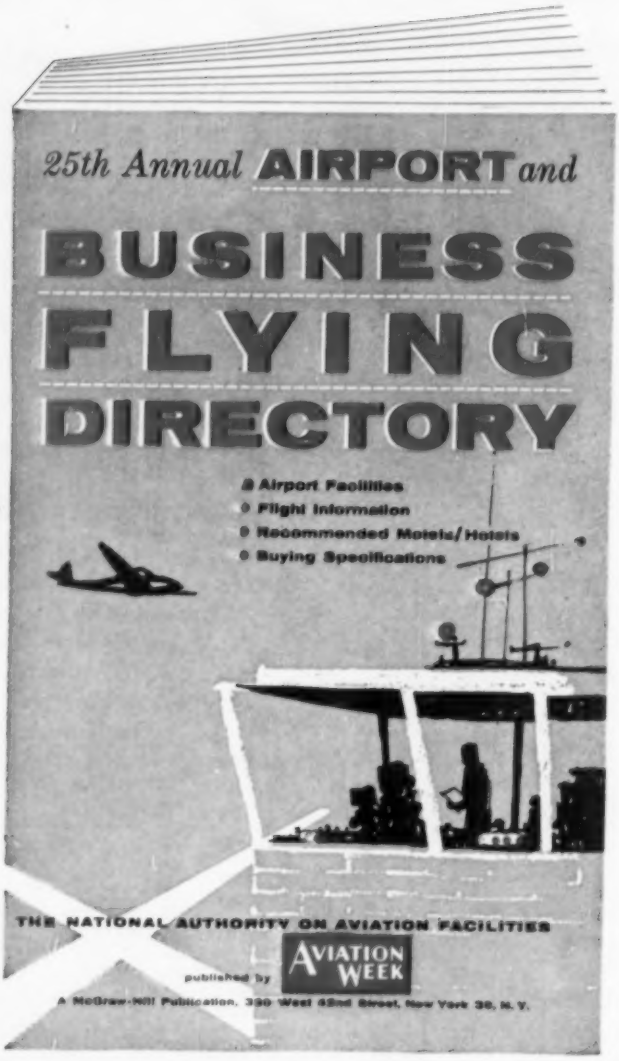

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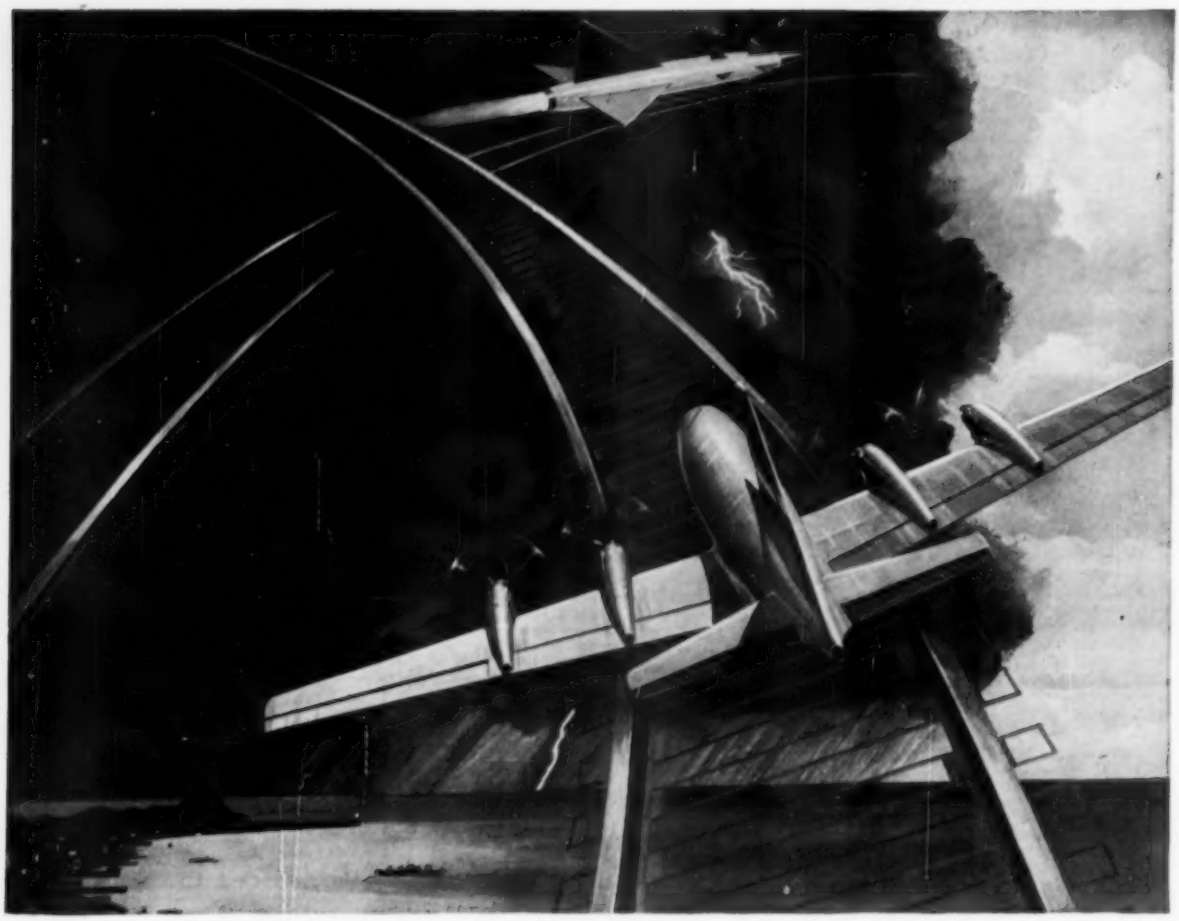

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LETTERS

Almost in Cockpit

The article "Blue Angels Do Serious Job for Navy" in the Nov. 18 issue of AVIATION WEEK (p. 71), by Erwin J. Bulban, was one of the finest jobs of aviation reporting that I have read in a long time. Mr. Bulban managed to get the "feel" of precision flying into his article in a manner which almost places the reader in the cockpit of an F11F.

AVIATION WEEK consistently does a good technical job on a highly technical subject. However, it is extremely difficult to create a feeling of reader participation while also presenting a rather complex subject in understandable language. Mr. Bulban did this in this case.

Your continued interest in the Navy is very much appreciated.

E. B. TAYLOR
Rear Admiral, U. S. Navy
Chief of Information
Department of the Navy
Washington, D. C.

Turkey vs. Bee

It seems to me that the administration and our scientists might drive a little harder on missiles and satellites if they realized how loud the Russians are laughing at us. The Blagonravov interview shows what a tremendous yak the Soviets are getting from our discomfiture.

I think your indignant letter-to-the-editor writer, Mr. Thurber from Norwalk, Conn. (AW Dec. 9, p. 134), ignored the fact that Mil was claiming a speed and altitude record for the Mil-4 *with a useful load of 4 metric tons (4,410 lb.)*. Offhand, I'd guess that the YH-39, which set the 156 mph. speed record in 1954, didn't carry any such load. If the Mil-4 is a "turkey," as Thurber says, it's a bit ridiculous to compare its speed with load record with that of a relative humble bee like the YH-39. The two craft simply aren't in the same class.

EX NAVAL OFFICER
Boulder, Colo.

Not Impressed

Re the letter "Danger of Satellite" written by Alfred Machado, Jr. (AW Nov. 25, p. 126), the transmutation of metals by means of atomic bombardment is an accomplished fact, but not at the distance (from satellite to earth) involved.

The production of isotopes is likewise an accomplished fact, but not by the atomic or electrical potential in a practical "Sputnik." It is quite true that light can be increased by amplification, but no progress has been made in this direction on gamma rays even for short distances, not to mention distances measured in hundreds of miles.

Your article does not consider that all concentrations of atomic energy are shielded by lead to prevent just such gamma rays from escaping. These walls of lead act equally as well in preventing the penetration of the "transmutation rays."

Your article does not consider that such a transmutation beam, if effective, would also destroy the atomic resources of the nation sending it up, as it would have to pass over the "point of origin" on each revolution.

Your article omitted the workmen in space suits who would assemble the finished "transmutation broadcaster" in space. It is the kind of article I would expect to find in a science fiction magazine, but not in AVIATION WEEK.

Your formulas appear to be without a specific characteristic of known quantity and effectiveness under conditions of satellite flight, and your implications of the destruction of our atomic and hydrogen bombs seem to be equally applicable to the enemy. I refuse to be either impressed or alarmed by such an article.

RICHMOND A. BOSLEY
Buffalo, N. Y.

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42 St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Inactive Engineers

More engineers! More scientists! And now the government has indicated an intent to produce more of these men. I have been spoon-fed so much of this type of propaganda that I now feel compelled to make my stand known. I am not a top-notch scientist, or an inhabitant of the Pentagon, but rather a run-of-the-mill engineer. I worked for an East Coast electronics manufacturer for five years and am now employed by a West Coast aircraft firm.

My point is this: there is no engineering shortage! I have seen large groups of competent engineers virtually sitting on their hands praying for some interesting and challenging work. Furthermore, within groups that do have work many engineers are doing work that would hardly be considered in line with their abilities. These observations are simply inconsistent with the picture presented to the American public.

I feel that there are two basic factors that have created this situation. The first factor is best summarized by a statement that was made to me by an official of my last employer. "You are not being paid for what you do, you are being paid to be here." I have since come to the conclusion that any given company will maintain a group of inactive engineers in hopes that when a contract comes along it will be in a position to handle it. This may be a good company policy, but when one considers the nationwide picture of inactive engineers, it is inevitable that the country as a whole is suffering immeasurably.

The second factor is closely tied in with interservice rivalry. The top Pentagon brass is so interested in getting their respective service on top that they are blind to the rat race they have put industry in. Quite understandably, each contestant wants to get the biggest piece of cheese.

These two factors have created a situation which is intolerable to many engineers who are not willing to prostitute themselves. It has, furthermore, given the public a very distorted view of the true picture. I could be wrong. To find out, I propose that all engineers who agree with me write to AVIATION WEEK to stand up and be counted.

JAMES RARICK
Santa Clara, Calif.

Inform People

Your editorials in AVIATION WEEK have always been illuminating and generally to the crux of the situation. "What We Really Need" (AW Dec. 2) is but the latest example of fine editorship. Unfortunately, they are directed to a relatively small group that are already devotees. A larger audience is needed.

I would like to see "What We Really Need" and many others like it on a prominent page of every newspaper in the country along with a direct appeal for every citizen to write, not only to Congress, but more importantly, to the Executive Branch and to the headquarters of each political party.

If President Eisenhower believes that scientists and engineers are just another pressure group, then our hands are tied until the entire population becomes a pressure group. Your editorials are certainly helping. However, to be really effective, a wider audience has to be activated to demand that government leaders think logically and act quickly.

It is believed that a blanket permission to newspapers to reprint your editorials would be another contribution toward informing the American people of where we stand and of the corrective measures so urgently needed.

J. A. BURKE, JR.
Executive Vice President
Experiment Incorporated
Richmond, Va.

(AVIATION WEEK editorials can be and are reprinted widely in daily newspapers, military publications, internal information digests of the Department of Defense and in industrial plant newspapers.—Ed.)

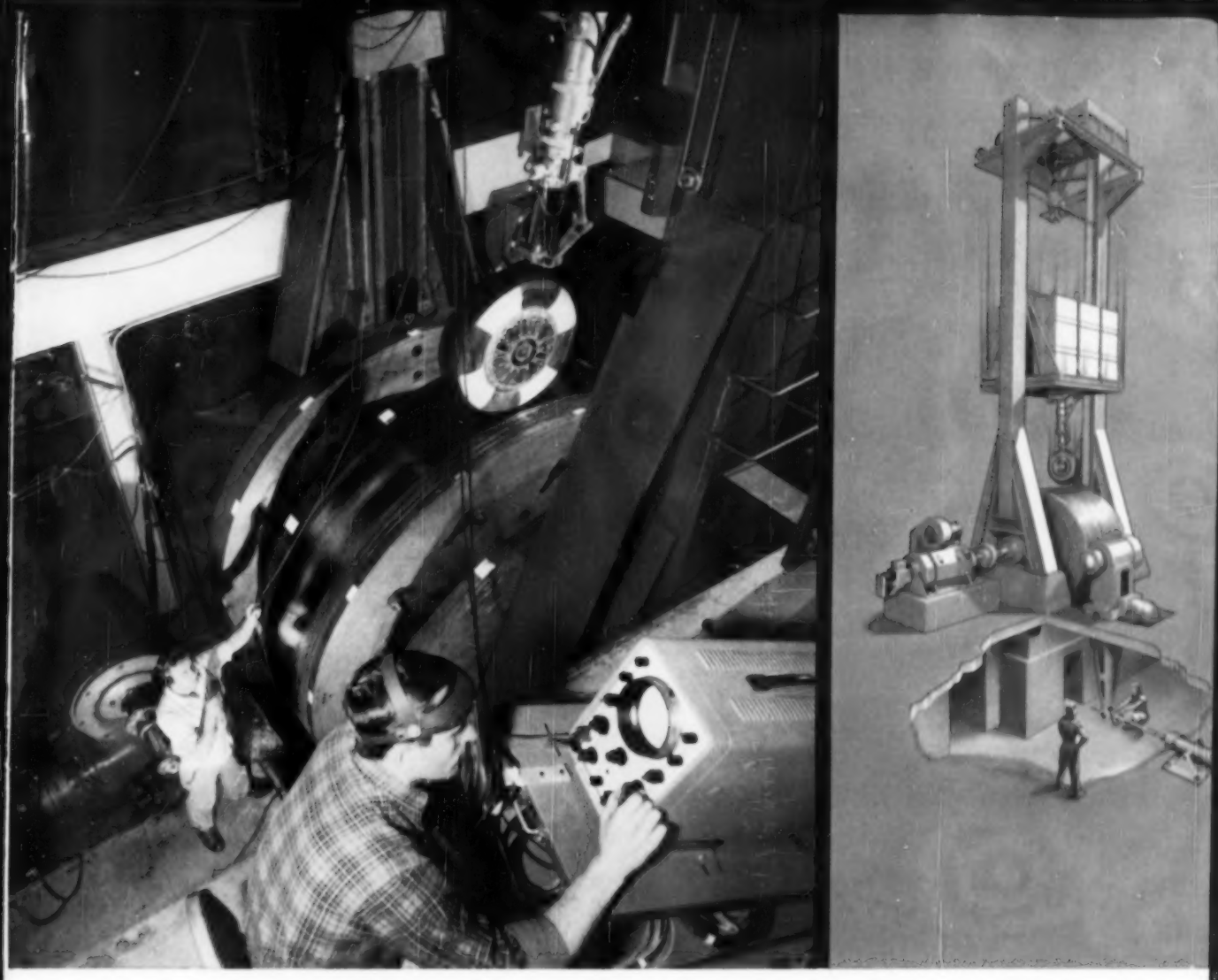
'Cosmonautics' Old

In the Nov. 11 issue, p. 29, the statement is made "Russia is calling its new science of space flight 'cosmonautics' . . ."

This is a word that has been used a long time in Russia. One of the most comprehensive books on the subject appeared in Moscow in 1937 with a French title page and table of contents added. It was Ary J. Sternfeld's *Initiation à la Cosmonautique*, a 300-odd-page technical treatment of space flight. Typical chapters were on history of cosmonautics, general rocket theory, physical and chemical processes, cosmic ships, take-off and landing, and the theory of relativity and cosmonautics.

Cosmonautics is nothing new in Russia.

FREDERICK I. ORDWAY, III
Project Director
General Astronautics Corp.
Huntsville, Ala.



Giant landing gear test facility is 60 feet high. It simulates conditions that heavy, high-speed planes actually meet.

BENDIX SHOOTS LANDINGS INDOORS TO HELP PRODUCE BETTER LANDING GEAR SYSTEMS

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New aluminum sheet gives Convair B-58

THINNER, TOUGHER SKIN

The new muscle in America's air arm, Convair's supersonic B-58 bomber, has a wing-skin that's probably the thinnest, toughest yet—bonded to an aluminum honeycomb section. This new construction method uses a new light-gauge, high strength, heat-treated aluminum alloy skin produced by Reynolds. It has the strength-weight ratio, the superior mechanical properties and the excellent surface qualities demanded of skins on a supersonic ship like the Air Force's B-58 "Hustler".

Whenever aviation advances, Reynolds Aluminum advances with it. And Reynolds goes beyond meeting material specifications. Reynolds technical services contribute to customers' design and engineering staffs—make Reynolds a part of many important industries rather than just a supplier.

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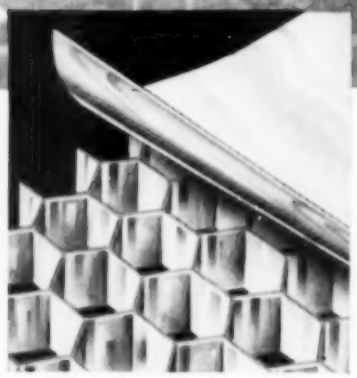

The above illustration shows how Reynolds new light-gauge, heat-treated, strong alloy sheet is bonded to an aluminum honeycomb for B-58 wing sections. This new skin material is available in a range of thin gauges, widths, lengths, and alloys for several airframe applications. A typical size in Alclad 7075-T6 is .010"x36"x120" in sheets, and in conventional coil lengths. Write for complete information and application assistance.

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